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ABSTRACT

Reported project objectives were to develop a pupil performance profile which describes the effects of specific instructional materials and management procedures on student performance and to develop a model which predicts pupil performance in a given set of materials under particular conditions. Instructional materials (Mathematics, M.W. Sullivan) were employed with 50 students (aged 6 to 11 years) of whom 24 were classified as having learning disabilities and 26 were classified as normal. An effort was made to assess only the contribution of the instructional materials by keeping contaminating factors such as differences in teaching styles or behavior management procedures to a minimum. The system was found to make the following information available for decision making by teachers: determination of student performance on three major measures by class or type of student, determination of performance on each measure by individual student, relationship of individuals' performance to that of their reference group (those in the same class and/or of the same type), distribution of performance by quartile ranking, and prediction of student performance. For both classes, there was found to be an inverse relationship between variability in performance within and across instructional materials and overall level of performance. (GW)

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FINAL REPORT

Project No. 572444
Grant No. OEG-X-71-0046(607)

EVALUATION AND SPECIFICATION OF INSTRUCTIONAL MATERIALS AND MANAGEMENT PROCEDURES THROUGH USE OF A PUPIL PERFORMANCE PROFILE AND A PREDICTIVE MODEL

Norris G. Haring, Project Director
Mark L. Berman, Principal Investigator

Experimental Education Unit
Child Development and Mental Retardation Center
University of Washington
Seattle, Washington 98195

June 30, 1972

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Department of Health, Education, and Welfare

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Department of Health, Education, and Welfare

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PREFACE

This project was designed to make several important steps toward the full-blown development of a methodology for the evaluation and specification of instructional materials and management procedures, as well as the prediction of student performance on instructional materials under various environmental conditions.

Numerous approaches exist for the evaluation and specification of materials. However, their success has been limited by insufficient emphasis on systematic analyses of data generated by students working on instructional materials. In regard to prediction of performance, little has been done to enable a teacher to deal with individual students.

Combining the promising features of existing methods with several novel elements, the research focused on the development of a Pupil Performance Profile and a predictive model. The Profile and the predictive model utilized data collected from several sources: the student whose performance we are attempting to assess and predict, and the performance of other students on the same or related materials. The overall goal is to improve learning through a comparison of individual student performance to that of other students, and the collection of fine-grain data regarding the differential effectiveness of various materials and management procedures on students of particular characteristics.

INTRODUCTION

A strong need exists to be able to specify, in advance, instructional materials as well as teaching and management techniques that are most likely to change the behavior of any given student. A need of similar magnitude exists for the development of more precise procedures for the evaluation of both instructional materials and management procedures.

Lumsdaine (1965) provides a thorough discussion of the evaluation of instructional materials, particularly programmed materials. He mentions three kinds of standards for evaluation: appropriateness, practicality, and effectiveness. The latter, which is most relevant to this research, refers to how well the instructional materials accomplished their objectives; in other words, does it teach what it says it teaches? Several indices of effectiveness, such as internal and external, are available. The former is revealed through inspection of materials, and involves such factors as format, prompting techniques, and kinds of student responses. The latter deals with information which cannot be secured through observation, for example, student performance on the materials.

As related by Lumsdaine, the two basic purposes of program effectiveness assessments are: (1) to provide a diagnostic basis for program revision; (2) to provide for the description of performance characteristics of a completed set of materials. Data from the latter indicate to the teacher the range of or mean performance to expect on particular instructional materials.

Lumsdaine stresses the importance of identifying the characteristics of the student who will be working on instructional materials. This serves several purposes: to identify the entering skills and knowledge of the students, so as to permit more precise determination of the amount of progress or improvement; to indicate the prerequisite information and skills necessary for successful performance on the materials; to enable the determination of whether or not the present population of students is typical or atypical of the students for whom the materials were designed.

A major approach used in the specification of instructional materials is Individually Prescribed Instruction (IPI). Cox (1966) describes the major concerns of IPI as being: (1) the definition of curricula in terms of a continuum of specific behavioral objectives, enabling precise measurement of pupil performance and progress in various subject-matter areas; (2) the provision of a range of instructional materials and techniques to meet the individual needs of students.

IPI seeks to provide conditions which allow students to work at their own pace, to learn with a minimum of direct teacher aid, to work only on materials which are compatible with their level of competence, and to reach certain minimum levels of mastery before proceeding to more difficult materials.

The goal of improved learning is facilitated by frequent evaluation of student progress. For purposes of evaluation four basic types of diagnostic instruments are used: (1) placement tests; (2) pre-tests; (3) curriculum embedded tests; (4) post-tests. Teachers and others involved in the learning process develop flexible sequences of learning experiences. Curricula are expressed in terms of behavioral objectives, and succeeding objectives are, when possible, built upon preceding objectives.

Analysis of placement testing results determines where each student should begin working on particular materials. As a result of this testing, which diagnoses the student's weaknesses, a prescription is developed for each student. The prescription lists the instructional materials which deal with weaknesses uncovered in the placement testing. By frequent measurement, through the use of tests at various junctures, and through precise specification of materials for particular learning problems, learning is facilitated.

Another recently-developed tool for the evaluation of instruction is Comprehensive Achievement Monitoring (CAM). A major focus of CAM is the discrepancy between expected and actual student performance. As discussed by Allen (1970), traditional classroom testing often does not illuminate possible differences between expectations and actual performance. Through pre- and post-test measurement, CAM, combined with systematic monitoring during instruction, can identify such discrepancies. Once identified, the discrepancies are brought to the attention of the teacher, who can then devise more effective instructional tactics. It is the thesis of CAM that, unless expected performance levels are precisely defined and specific information about performance is available, there will be only slight influence on the teacher to change tactics and, hopefully, improve instruction.

Somewhat related to IPI is the Keydex system, devised to aid in the specification of materials for students with particular learning problems (Adamson and Van Etten, 1970). The user of the system first determines which descriptor terms, i.e., the characteristics of particular materials indexed in the Keydex system, are relevant to an academic problem in the classroom. At times, no materials may contain the relevant descriptors or all of the descriptors. On other occasions many materials may contail all relevant descriptors, causing the user to select additional descriptors so as to pare down the materials to a manageable number.

At present, no single approach to evaluation and specification of instructional materials is without flaw. Many contain one or more highly promising aspects which, when judiciously combined, may prove to be significantly more valuable than any given available approach. Perhaps the major criticism of current practices, whether related to specification or evaluation, is that they generally focus on characteristics of the materials (Lumsdaine's internal index of program effectiveness), rather than on analyses of data generated by students working through the materials.

Management procedures are another important aspect of the instructional system. The methods teachers use to increase desirable behaviors and decrease undesirable behaviors in the classroom may greatly affect student performance. Often, however, the individual teacher is forced to devise new methods and procedures on the spot, for lack of validated evidence concerning the effects of various procedures used in a range of situations.

It seems that a more systematic approach than "try, try again" may prove more effective. In general, procedures are changed on a trial-and-error basis. If one management technique fails then another is selected, almost at random. At the very least the procedure is selected on the basis of the experience of the single teacher involved. This is wasteful of time and other resources, and may be detrimental to students' intellectual and social development, if students often experience failure in the classroom.

It would be very useful to have information concerning the effects of specific management procedures on specific "types" of students on specific instructional materials. Cronbach (1969) has conducted research which relates to this aim. He has dealt with the interaction between "learning abilities" and instructional treatments, naming this work Aptitude Treatment Interaction or ATI. The basic premise of ATI is that characteristics of learners affect their attainment of educational goals. Two major goals of ATI are: (1) that different instructional methods are needed for different kinds of students in order to achieve the same instructional objective; (2) personality dimensions, as well as aptitude, should be a criterion for academic placement. Cronbach observes that the principles governing the matching of learner to individualized instruction environment are not yet known, and that we have very little information concerning the relationship of personality variables to instructional procedures.

We would benefit greatly from objective means of specifying, with a particular probability of success, which procedures will work for particular "types" of students on particular kinds of materials, before the procedures are implemented or materials handed out to the students. Preciseness of specification will be based on the accumulated experience and success of hundreds of teachers and thousands of students, as contrasted with the typical hit-and-miss, "seat of the pants" approach.

RESEARCH OBJECTIVES

The project had two basic research objectives. The first objective was the initial development of a Pupil Performance Profile, which is a description of the effects of specific instructional materials and management procedures on student performance. This involves specification of how students of differing characteristics perform on particular materials under various environmental conditions. The Pupil Performance Profile includes the following information: (a) the "type" of student involved, i.e., his characteristics such as scores on standardized tests and his grade level; (b) the instructional materials involved; (c) the management procedures used, if any; (d) student performance in terms of correct and error rate per minute, plus additional dependent variables where relevant.

Efforts to predict student academic performance have generally been carried out at the macro-level. For example, many studies have utilized personality characteristics or scores on standardized tests to predict grade-point average. Results of such predictions have been mixed. Assuming, however, that we could always predict grade-point average from such variables as scores on personality inventories, of what value is this to the individual teacher dealing with a particular student working with certain instructional materials?

Therefore, the second objective involved using data from the Pupil Performance Profile to begin the development of a model which enables the prediction of pupil performance in a given set of materials under particular conditions. The predictive model is intended to serve general purpose functions, that is, be usable in any setting, assuming that data is available regarding the important variables which are involved in the prediction process. In addition, the model utilizes data generated by the individual students whose performance we will be attempting to predict. The following outline indicates the relationships between the performance of the individual student and the performance of other students:

Some Possible Sources of Input for the Predictive Model:

I. Individual Student Measures

   A. Performance on preceding portions of the present set of materials, e.g., frames 1-100 of BRL Mathematics.

   B. Performance on related materials, e.g., Sets and Numbers. (Suppes and Suppes, 1968)

   C. Performance on related activities not classifiable as materials, e.g., classroom discussion.

   D. Other relevant data, including, perhaps, students' preference for particular kinds of materials, particular kinds of reinforcers, for working accurately as opposed to rapidly, and so on.

II. Group (Other Student) Measures

A. Performance on preceding portions of the present set of materials, e.g., frames 1-100 of BRL Mathematics.

B. Performance on immediately upcoming (for the individual student) portions of the present material, e.g., frames 101-200 of BRL Mathematics.

C. Performance on related materials, e.g., Sets and Numbers.

D. Other relevant data.

The following chart illustrates the application of the predictive model:

	Performance of Individual Student on Materials (no contingencies in effect)	Performance of Other Students on Same Materials (w/contingencies in effect)	Performance of Other Students on Same Materials (no contingencies in effect)
Frames 1-100:	Correct=2.8/min.	Mean correct=3.9/min. Minimum correct=2.6/min. Maximum correct=5.0/min.	Mean correct=3.5/min. Minimum correct=2.5/min. Maximum correct=4.7/min.
	Error=4.1/min.	Mean error=2.0/min. Minimum error=0.7/min. Maximum error=4.4/min.	Mean error=2.8/min. Minimum error=1.2/min. Maximum error=4.6/min.
101-200:	(Student has not yet begun these frames)	Mean correct=3.0/min. Minimum correct=2.6/min. Maximum correct=3.9/min.	Mean correct=2.9/min. Minimum correct=2.7/min. Maximum correct=4.1/min.
		Mean error=2.8/min. Minimum error=1.4/min. Maximum error=4.6/min.	Mean error=2.9/min. Minimum error=1.5/min. Maximum error=4.8/min.

Given the above information, how might we structure both the type of materials presented to the individual student and the nature of the management procedures in order to improve his performance? The preceding chart supplies several basic pieces of data from which to make such decisions. First, the individual student's correct rate on frames 1-100 was lower than the other students' mean correct rate on those frames. The individual student's error rate on those frames was higher than the other students' mean error rate. Second, the mean correct rate of the other students, regardless of whether or not a contingency system was in effect, was lower for frames 101-200 than it was for frames 1-100. This was accompanied by a higher mean error rate for frames 101-200 as compared to frames 1-100. Third, the students operating under a contingency system did better, in terms of higher correct rate and lower error rate, on frames 1-100 and 101-200 than did students not operating under a contingency system.

From the preceding, three conclusions may tentatively be drawn: (1) the individual student we are dealing with had considerably more difficulty with the initial (frames 1-100) portions of the material than did the average student. In fact, this student's correct rate was very close to the minimum rate for the other students; (2) the second 100 frames of the materials are more difficult than the first 100 frames, as indicated by both lower correct and higher error rates for the other students on the second 100 frames; (3) the contingency system produced better performance than did baseline conditions, for both frames 1-100 and 101-200.

Armed with this information, we can predict several things about the individual student's performance on the immediately upcoming frames (1-100): First, that we can, all things being equal, expect a decrease in correct and an increase in error rate on these frames. Second, we can expect that this student will have a lower correct and a higher error rate on these frames than did the average of the other students who have worked through the same materials. Third, that a contingency system will increase correct and decrease error rate on these frames.

We now have the means for specifying, in advance, the performance of the individual student, in addition to knowledge of which management procedure will most improve performance. If we also have data regarding the performance of students of similar "type" on other materials dealing with the same subject matter, we can also predict whether or not the individual student's performance will improve or deteriorate if shifted to these other materials.

Research Methods and Procedures

Subjects

Fifty students, of which 24 were classified as having learning disabilities and 26 classified as normal, were engaged in the project. The students with learning disabilities were taught in a separate classroom from the normal children, though all teachers had comparable training and backgrounds and used approximately the same teaching techniques.

The students were from six to eleven years of age. The students classified as having learning disabilities were located in a single classroom during the time of day that they were involved with the project and returned to one of three classrooms when not engaged in the project. The students classified as normal exhibited a range of academic and social competence, though all fell within the range considered acceptable for their age and grade level (seven years, second grade). The learning disabled students (ages six to eleven) exhibited a variety of academic and social deficits, which led to their placement in special classes.

Materials

The instructional materials utilized in the project were Mathematics (M.W. Sullivan. Palo Alto, California: Behavioral Research Laboratories, 1970). This is a programmed set of 37 booklets, designed to meet the needs

of a wide range of students, from those with no background in mathematics to those with fairly extensive experience. Students began on pre-tests provided by the publisher.

Teachers

The four teachers involved in the project had received at least minimal training in precision teaching prior to beginning the project and hence were familiar with basic measurement techniques. The normal students were taught by a single teacher in a second grade classroom, whereas the learning disabled students were taught by a teacher and an aide.

Behavior Management Procedures

Essentially the same behavior management procedures were employed by all teachers involved in the project, though minor variances occurred at particular times and for particular students when circumstances warranted. The prevailing procedure was to utilize only verbal praise, e.g., "good job" or "you are correct", contingent upon accurate work.

Experimental Design

We attempted to provide comparable conditions, in terms of teachers' training, instructional materials utilized, and behavior management procedures in effect, for the two groups of students involved. The purpose was to get as clear a picture as possible of the contributions of the instructional materials themselves to student performance, and to keep contaminating factors, such as differences in teaching styles or behavior management procedures, to a minimum.

The project focused upon the following dependent variables: (a) correct and error rate on the instructional materials; (b) percentage correct; (c) elapsed time per page. In future work, as procedures for gathering and analyzing data are further refined, it will be possible to gather data concerning such factors as social behavior while working on the materials, retention of information and skills, and students' and teachers' comments regarding individual items, pages, and books. In regard to independent variables, the focus was upon student type, e.g., learning disabled or normal.

DATA COLLECTION AND ANALYSIS

All students worked for ten minutes per day on the instructional materials. This facilitated comparison of the performances of different students by standardizing their daily output. Direct readout clocks, supplied by the Project, were used by students to record the elapsed time each spent working on each page of the materials. A timer was supplied each teacher, to determine the end of each of the fixed length periods of student work on the materials.

Raw data includes the following: page and book identification number; date; student by class; number of movement cycles on the page; number of correct movement cycles on the page; number of incorrect movement cycles on the page; start time; stop time; frames missed.

A project aide corrected the students' work and other personnel transferred the raw data to key punch form. The information was then key-punched.

A data log (see Appendix A) was constructed on the basis of the dependent variables of greatest interest, in addition to the need for facilitating transfer of data both from the instructional materials to the log and from the log to computer cards. The data log contains the following information: student identification number, book number, page number, number of items correct on each page, number of items incorrect on each page, number of items incomplete or omitted on each page, and the start and stop times for each page.

The computer stored a master list of the total number of items on each page for each of the 37 books in the instructional series. If there was a variance between the number of items on file and the number of items on the computer card (as secured from the data log), the computer rejected that card. We then went back either to the data log, the computer card, or to the actual book which the student had worked on. Initially about five percent of the data cards were rejected, due mainly to errors in recording from the books themselves.

The following data report forms were developed:

A. Status Report (See Appendix B)

This report lists, by page, all students who have completed a minimum number of pages in each book, according to whether speed and/or accuracy data is available for that page and for that student. The status report lists the identification number of each student who has completed a specified minimum number of pages in the book, and designates with a "T" those pages for which we have both speed and accuracy data for the particular student. The designation "S" indicates that we only have accuracy data for that page for a particular student. The absence of either designation indicates that we have neither speed nor accuracy data for that page for the particular student.

The computer can be instructed to print the status report on a calendar basis, e.g., every day, week, month, semester, or print only when a minimum number of students have completed a minimum number of pages. This provides us with a means of determining when it is necessary and economical to print intensive reports of individual student performance or reports which present data averaged across students.

B. Book Completion Report by Student (See Appendix C)

This report lists the number of correct, incorrect, and incomplete problems, by page in a particular book, for individual students. We also receive, again by page, a measure of performance quality (the percentage

correct of all problems completed, excluding incomplete problems from the computation), as well as performance efficiency (the percentage correct of all problems possible on the page, regardless of whether or not they were completed by the student). The book completion report by student presents elapsed time per page and correct and error rates per minute per page. Correct and error rates per minute are computed by dividing the total number of correct responses per page by the total time to complete the page (in the case of correct rate), and by dividing the total number of incorrect responses per page by the total time to complete the page (in the case of error rate). The computer also stars (*****) the five highest correct rates and the five highest error rates in each book for the individual student. This facilitates location of those pages on which students experienced little or a great deal of difficulty. The report presents the student's quartile rank on each page for elapsed time and correct rate.

We also receive the average quality, efficiency, time per page, quartile rank, and correct and error rates across the entire book by student. Two averages are involved here; one is computed only for the pages on which time was recorded, the other for all pages on which we have any data. Finally, the book completion report by student presents cumulative totals for all measures, with a separate total computed for pages on which time was recorded and for pages on which time was not recorded.

C. Book Completion Report Across Students, Type 1 (See Appendix D)

This report contains by class, the following information: book number, page number, number of students completing that page, average number of items correct, average number of items incorrect, average number of items incomplete, average quality and efficiency, total number of items on that page, the number of students for which we have speed data on that page, average elapsed time, correct and error rates, as well as the standard error of the mean for elapsed time and correct and error rates.

D. Book Completion Report Across Students, Type 2 (See Appendix E)

This report contains by class, the following information: book number, page number, number of students completing each page, and the minimum, first quartile, median, third quartile, and maximum scores for both elapsed time per page and correct rate per page. The report can easily be expanded to include the minimum, first quartile, median, third quartile, and maximum error rates. Finally, this report presents averages for all measures (e.g., average median elapsed time per page, average third quartile correct rate per page).

RESULTS

This section is divided into three parts: (A) Pupil Performance Profile, (B) The Predictive Model, (C) Comparisons Between Normal and Learning Disabled Students.

A. Pupil Performance Profile

The major objective of this project was the initial development of a means for describing and evaluating student performance on instructional materials under various behavior management procedures. This information would be used by teachers, administrators, and others, to determine the effectiveness of the materials and management procedures, and to predict when individual students and types of students will experience difficulty on upcoming materials and with particular management procedures. This will enable specification of those materials and procedures which have the highest probability of proving effective.

The main measures are as follows: (a) average right, wrong, and omitted responses per page for all books on which students worked, (b) average quality and standard error per page for all books, (c) average efficiency and standard error per page for all books, (d) average elapsed time and standard error per page for all books, (e) average correct rate and standard error per page for all books, (f) average error rate and standard error per page for all books, (g) the number of students for whom we have measures (a) through (c) on each page for all books, (h) the number of students for whom we have measures (d) through (f) for all books, (i) the total number of responses possible per page, (j) the minimum, first quartile, median, third quartile, and maximum elapsed time per page for all books, (k) the minimum, first quartile, median, third quartile, and maximum correct rate per page for all books, (l) the averages, across all pages within each book for measures (j) and (k) for all books, (m) the number of students for whom we have measures (j) and (k) on each page for all books.

Table 1 presents averages, for elapsed time and correct rate, of the minimum, first quartile, median, third quartile, and maximum scores on each of these two measures, by class.

Table 1 illustrates the superiority of class two (normal students) over class one (learning disabled students) on the same books. For example, on books 13-17, the mean-median elapsed time for class two is lower for every book than is the same measure for class one. For the same books, class two has a higher mean-median correct rate than class one in four of five instances.

Figures 1, 2, 3, and 4 present, by class, the minimum, first quartile, median, third quartile, and maximum score distributions for elapsed time and correct rate, by book.

CLASS ONE

Book No.	Ave. No. Subj.	ELAPSED TIME Mean Min.	Mean 1st Quartile	Mean Median	Mean 3rd Quartile	Mean Max.	CORRECT RATE Mean Min.	Mean 1st Quartile	Mean Median	Mean 3rd Quartile	Mean Max.
2	2.1	78.4	78.4	103.4	131.6	134.8	3.58	3.58	4.55	6.41	6.84
3	3.1	57.8	60.2	99.6	190.5	199.4	2.25	2.25	4.32	7.21	7.49
4	2.7	59.6	60.2	97.8	166.7	168.7	2.23	2.27	4.38	7.18	7.28
5	2.3	49.3	49.3	76.[illegible]	126.2	126.9	3.41	3.41	5.22	7.43	7.63
13	5.6	41.3	54.5	85.4	133.7	165.6	3.44	4.23	6.42	11.44	15.67
14	6.0	79.7	99.8	144.9	227.7	303.8	2.59	3.33	5.06	8.00	10.77
15	6.2	53.9	74.0	116.3	212.3	281.2	2.35	3.10	5.37	9.05	13.64
16	4.6	74.4	85.5	137.8	227.6	259.7	2.26	2.67	4.55	8.34	9.91
17	4.4	49.9	56.7	92.8	180.2	215.0	2.55	3.16	6.55	11.81	13.35
18	2.6	111.0	114.8	167.3	237.6	244.4	3.50	3.73	6.50	11.57	12.80
19	1.1	107.1	107.1	110.7	113.4	114.3	5.83	5.83	6.05	6.18	6.28
20	1.9	155.6	155.6	209.9	249.9	270.9	3.44	3.44	5.29	7.51	7.57
21	1.8	212.2	212.2	271.2	297.1	330.1	2.72	2.72	3.70	6.12	6.67
22	1.4	109.8	109.8	129.1	145.7	148.4	6.97	6.97	7.87	8.97	9.07

TABLE 1, PAGE 1: ELAPSED TIME AND CORRECT RATE:
QUARTILE RANKINGS BY BOOK AND CLASS

CLASS TWO

Book No.	Ave. No. Subj.	ELAPSED TIME Mean Min.	Mean 1st Quartile	Mean Median	Mean 3rd Quartile	Mean Max.	CORRECT RATE Mean Min.	Mean 1st Quartile	Mean Median	Mean 3rd Quartile	Mean Max.
5	1.8	60.7	60.7	77.5	107.7	110.7	3.91	3.91	5.39	6.51	6.87
6	2.9	50.2	51.9	85.0	131.0	132.9	3.12	3.19	4.92	9.26	9.57
7	5.2	42.1	50.4	77.4	122.9	149.4	2.25	2.70	4.41	8.24	10.91
8	5.7	26.3	39.3	73.5	120.8	153.1	2.21	2.89	4.70	10.65	16.02
9	6.3	23.9	39.6	77.1	128.3	172.4	1.83	2.65	4.92	11.60	20.47
10	11.6	27.1	53.1	92.2	134.6	216.9	1.54	2.73	4.25	8.16	16.54
11	8.0	38.1	59.6	88.7	124.3	171.9	1.90	2.88	4.33	6.72	11.62
12	7.0	31.4	47.6	71.8	105.3	137.1	3.98	4.97	7.16	10.95	18.72
13	12.0	29.9	56.1	85.2	127.8	227.7	2.44	4.07	6.09	9.38	20.25
14	9.9	60.5	95.6	140.0	196.4	305.9	2.51	3.78	5.17	7.71	13.13
15	9.2	39.7	59.9	87.4	123.5	188.8	3.33	4.72	6.73	9.97	17.26
16	5.2	40.2	56.1	95.6	134.4	160.7	4.35	5.00	7.65	13.59	16.77
17	1.9	34.4	34.4	47.7	69.0	71.0	8.57	8.57	13.62	15.79	18.68

TABLE 1, PAGE 2: ELAPSED TIME AND CORRECT RATE:
QUARTILE RANKINGS BY BOOK AND CLASS

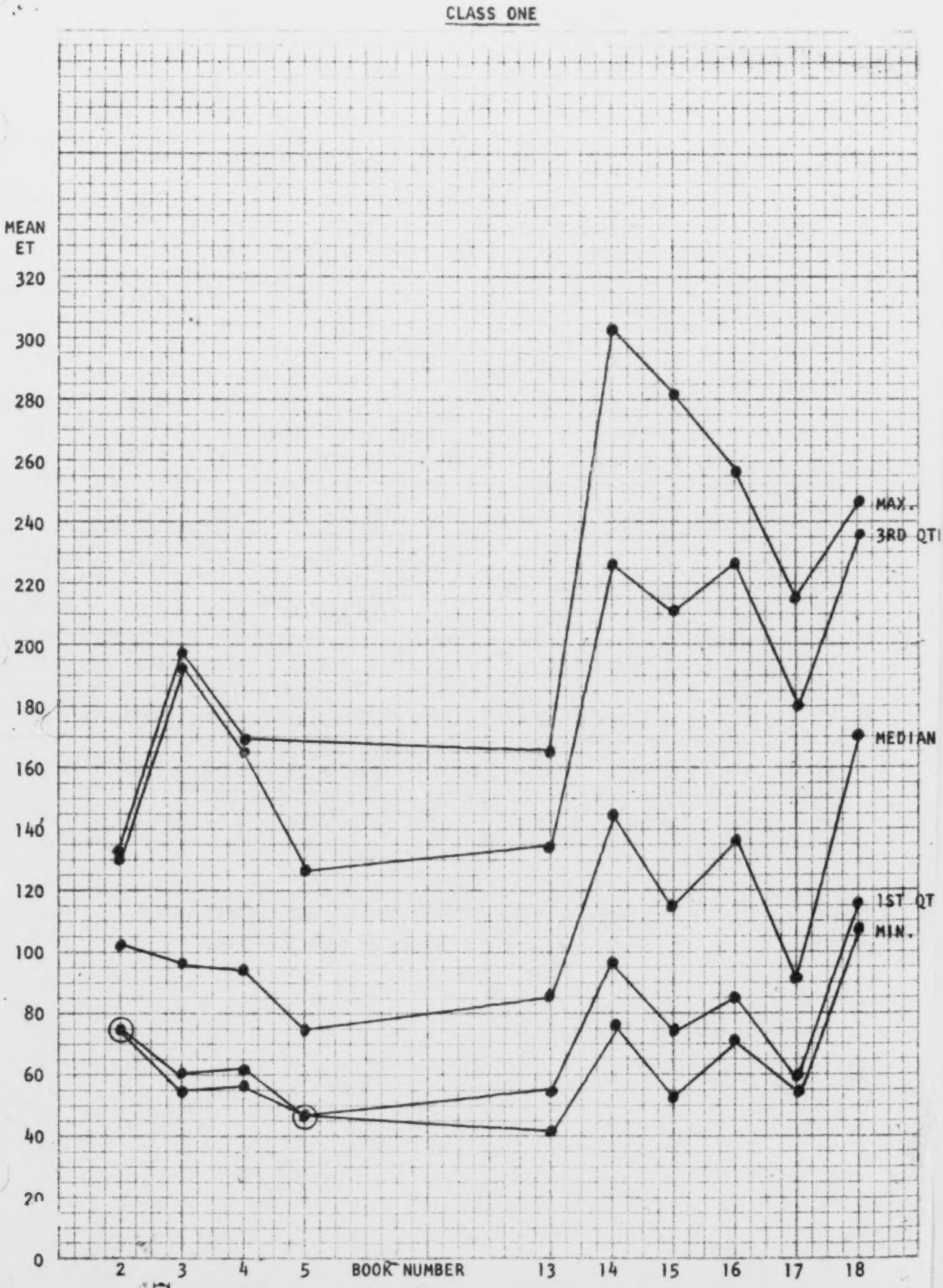


FIGURE 1: QUARTILE DISTRIBUTIONS, ELAPSED TIME, CLASS ONE

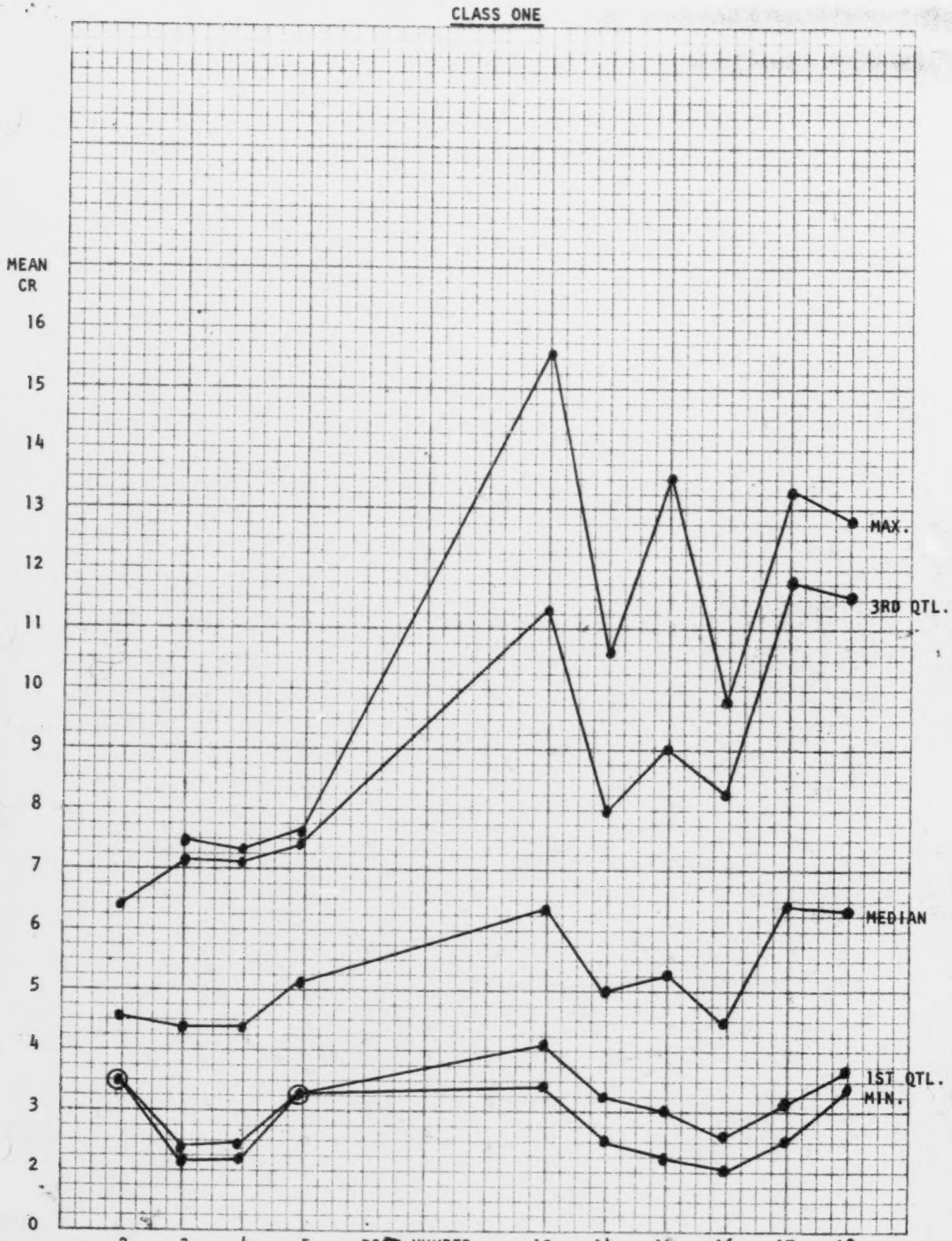


FIGURE 2: QUARTILE DISTRIBUTIONS, CORRECT RATE, CLASS ONE

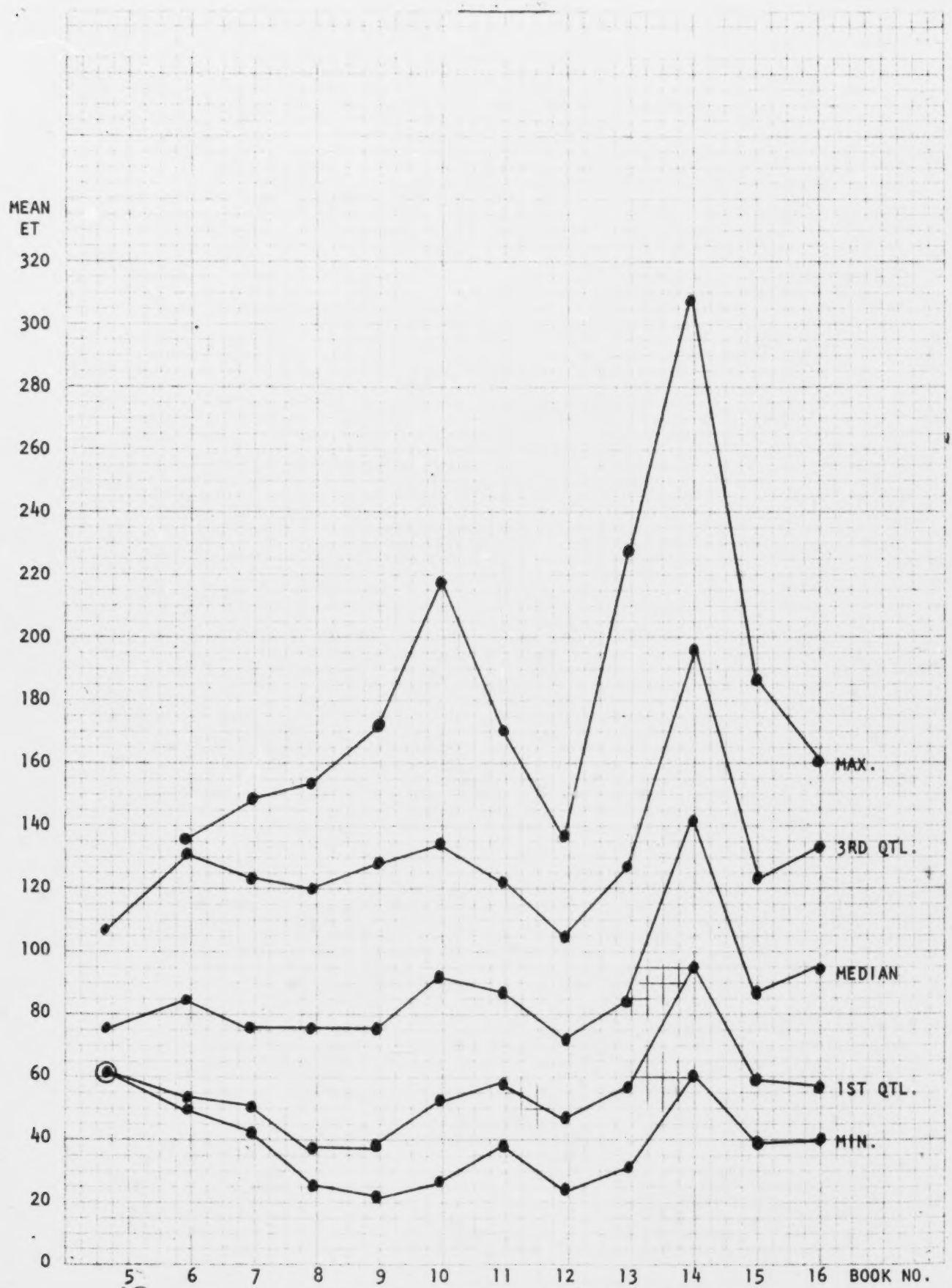


FIGURE 3: QUARTILE DISTRIBUTIONS, ELAPSED TIME, CLASS TWO

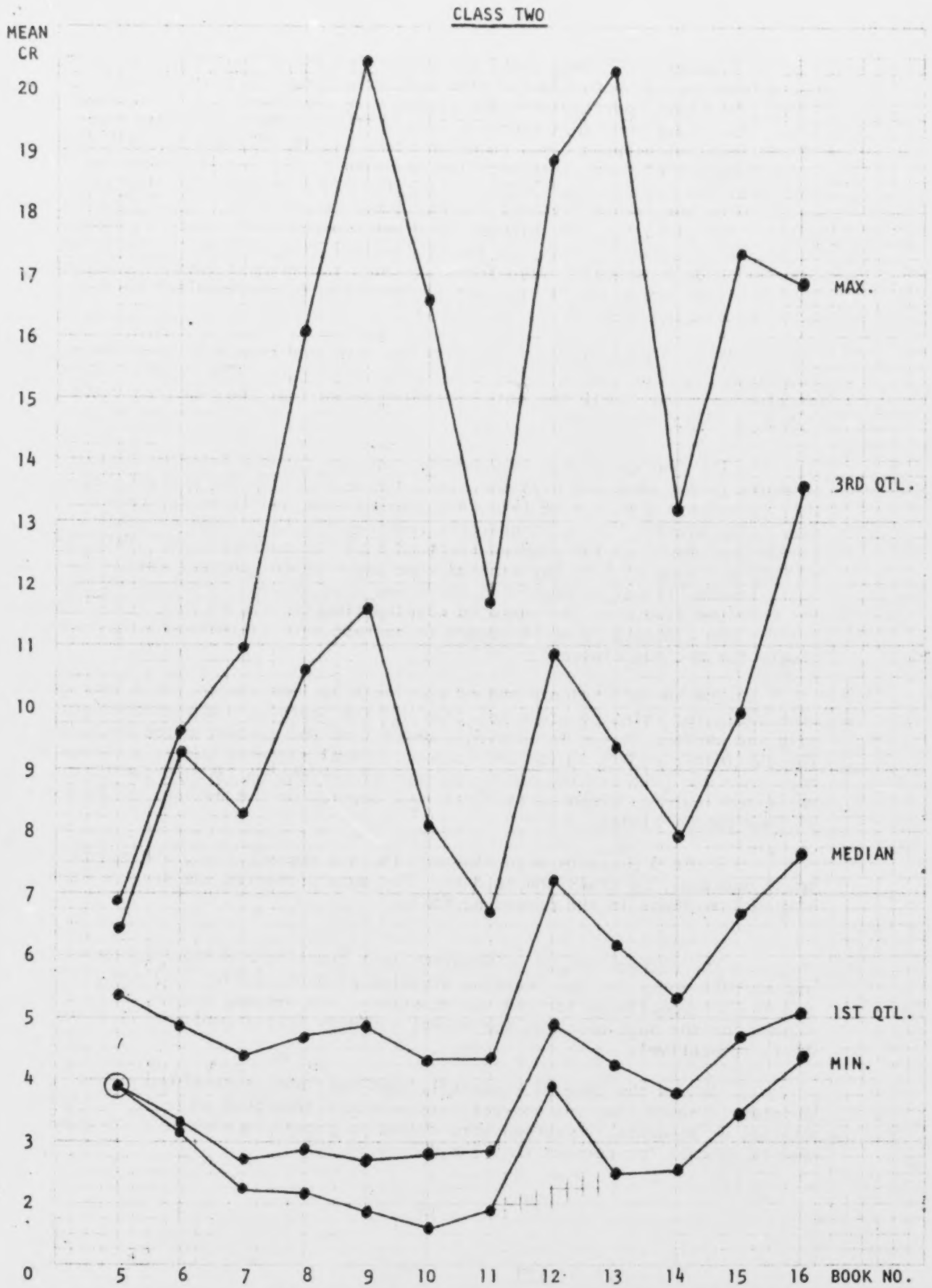


FIGURE 4: QUARTILE DISTRIBUTIONS: CORRECT RATE, CLASS TWO

Figures 1 - 4 show that, for class one, there is a definite trend toward increases in both elapsed time and correct rate as they proceed through the books, particularly for students in the third and fourth quartiles. For class two, this trend is less definite. For class one, the highest (median) elapsed times occur on books 14, 15, 16, and 18, with the lowest (median) elapsed times occuring on books 5, 13, and 17. Also for class one, the highest (median) correct rates occur on books 13, 15, 17, and 18, with the lowest (median) correct rates occuring on books 2, 3, 4, and 16. For class two, the highest (median) elapsed times occur on books 10, 11, 14, 15, and 16, with the lowest (median) elapsed times occuring on books 5, 7, 8, 9, and 12. Also for class two, the highest (median) correct rates occur on books 12, 13, 15, and 16, with the lowest (median) correct rates occuring on books 7, 8, 10, and 11.

Table 2 presents mean quartile rankings and change in rankings by student and by book, for elapsed time and correct rate. The students were selected at random, with the only criterion being that they must have completed at least three books.

The average change in quartile rankings for the learning disabled students (class one) was 0.73 for elapsed time and 0.57 for correct rate. This represents a change of 14.6% for elapsed time and 11.4% for correct rate. The average change in quartile rankings for the normal students (class two) was 0.25 for elapsed time and 0.57 for correct rate. This represents a change of 5.0% for elapsed time and 4.6% for correct rate. For both classes, it may be seen that there was more change, from book to book for selected students, in regard to elapsed time (14.6% and 5.0% respectively for the two classes), than in regard to correct rate (11.4% and 4.6% respectively for the two classes).

The normal students showed considerably less change, on a book to book basis for selected students, than did the learning disabled students, with the average change (combining elapsed time and correct rate) being 4.8% for the former and 13.0% for the latter. Normal students showed a change of more than one full ranking on the average of one out of 23 opportunities, while for learning disabled students this occured on the average of one out of four opportunities.

Table 3 presents mean elapsed time and correct rate, and change in these measures, by class and student. The data presented are for the same students as those in the preceding table.

The average change in absolute (not quartile rankings) elapsed times and correct rates for the learning disabled students (class one) was 57.1% and 46.0% respectively for the two measures. The average change in absolute scores for the same measures for normal students (class two) was 35.1% and 21.1% respectively.

As was the case with quartile rankings, when assessing changes in absolute elapsed time and correct rate measures from book to book, for both classes of students, there was more change in regard to elapsed time (57.1% and 35.1%)than for correct rate (46.0% and 21.1%).

CLASS ONE

Subj. No.	Book No.	Mean Quartile Rank: Elapsed Time	Change from Last Book	Mean Quartile Rank: Correct Rate	Change from Last Book
205	14	2.70	-	2.60	-
205	15	4.17	1.47	3.96	1.36
205	16	2.37	1.80	2.49	1.47
205	17	3.36	0.99	3.07	0.58
205	18	2.79	0.57	3.23	0.16
207	15	1.99	-	1.96	-
207	16	1.34	0.65	1.63	0.33
207	17	1.86	0.52	1.75	0.12
303	13	2.95	-	2.76	-
303	15	2.91	0.04	2.69	0.07
303	16	3.25	0.34	3.25	0.56
307	13	1.68	-	1.66	-
307	14	1.84	0.16	1.74	0.08
307	15	3.04	1.20	2.93	1.19
308	13	2.62	-	2.57	-
308	14	3.27	0.65	3.22	0.65
308	15	2.96	0.31	2.93	0.29
Average:			0.73 (14.6%)		0.57 (11.4%)

TABLE 2, PAGE 1: MEAN QUARTILE RANKINGS AND RANKING CHANGES, BY CLASS AND STUDENT FOR ELAPSED TIME AND CORRECT RATE

CLASS TWO

Subj. No.	Book No.	Mean Quartile Rank: Elapsed Time	Change from Last Book	Mean Quartile Rank: Correct Rate	Change from Last Book
401	14	2.25	-	2.12	-
401	15	2.17	0.08	2.16	0.04
401	16	2.55	0.38	2.37	0.21
407	13	3.97	-	3.84	-
407	14	4.18	0.21	4.11	0.27
407	15	4.11	0.07	3.99	0.12
407	16	3.88	0.23	3.73	0.26
409	13	2.52	-	2.40	-
409	14	2.70	0.18	2.48	0.08
409	15	1.82	0.88	1.69	0.79
415	13	2.32	-	2.35	-
415	14	3.65	1.33	3.58	1.23
415	15	3.34	0.31	3.15	0.43
416	13	2.01	-	1.91	-
416	14	2.32	0.31	2.05	0.14
416	15	2.00	0.32	1.89	0.16
418	13	1.71	-	1.59	-
418	14	1.78	0.07	1.78	0.19
418	15	2.29	0.51	2.23	0.45
420	13	2.92	-	2.88	-
420	14	3.14	0.22	2.93	0.05
420	15	3.49	0.35	3.33	0.40
420	16	4.14	0.65	3.86	0.53
422	13	2.73	-	2.65	-
422	14	2.41	0.32	2.35	0.30
422	15	2.97	0.56	2.91	0.56
423	13	1.70	-	1.75	-
423	14	1.90	0.20	1.96	0.21
423	15	1.42	0.48	1.62	0.34
423	16	1.13	0.29	1.46	0.16
425	13	1.77	-	1.82	-
425	14	2.05	0.28	2.05	0.23
425	15	2.21	0.16	2.21	0.16
Average:			0.25 (5.0%)		0.23 (4.6%)

TABLE 2, PAGE 2: MEAN QUARTILE RANKINGS AND RANKING CHANGES, BY CLASS AND STUDENT FOR ELAPSED TIME AND CORRECT RATE

CLASS ONE

Subj. No.	Book No.	Mean Elapsed Time	Change from Last Book(%)	Mean Correct Rate	Change from Last Book(%)
205	14	159	--	5.07	--
205	15	66	58.5	11.04	217.7
205	16	162	245.5	5.45	50.7
207	15	163	--	5.00	--
207	16	217	33.1	3.34	33.2
207	17	145	33.2	5.19	55.4
303	13	107	--	7.05	--
303	15	134	25.2	7.43	5.4
303	16	119	11.2	8.01	7.8
307	13	129	--	5.46	--
307	14	204	58.1	4.24	22.3
307	15	104	49.0	6.47	52.6
308	13	90	--	6.64	--
308	14	130	44.4	6.37	4.2
308	15	113	13.1	7.02	10.2
Average:			57.1%		46.0%

TABLE 3, PAGE 1: MEAN ELAPSED TIME AND CORRECT RATE, AND CHANGES IN THESE, BY CLASS AND STUDENT

CLASS TWO

Subj. No.	Book No.	Mean Elapsed Time	Change from Last Book	Mean Correct Rate	Change from Last Book
401	14	178	--	5.08	--
401	15	104	41.6	7.88	55.1
401	16	92	11.6	8.19	3.8
407	13	50	--	12.53	--
407	14	82	64.0	10.08	19.6
407	15	53	35.4	12.86	27.5
407	16	52	1.9	13.99	8.7
409	13	99	--	6.14	--
409	14	142	43.4	5.34	13.2
409	15	116	18.3	5.40	1.1
415	13	99	--	6.40	--
415	14	100	1.0	8.25	28.9
415	15	72	28.0	9.81	18.9
416	13	115	--	5.48	--
416	14	152	32.7	4.87	11.1
416	15	117	23.1	5.62	15.6
418	13	126	--	4.53	--
418	14	185	46.8	4.47	1.4
418	15	102	44.7	6.50	45.4
420	13	77	--	7.45	--
420	14	115	49.2	6.90	7.4
420	15	67	41.7	9.69	40.4
420	16	49	26.8	14.69	51.6
422	13	83	--	7.30	--
422	14	158	90.4	5.44	24.3
422	15	77	51.3	8.42	54.8
423	13	129	--	5.10	--
423	14	178	37.9	4.79	6.1
423	15	126	29.2	5.39	12.5
423	16	130	3.2	5.32	1.3
425	13	129	--	5.17	--
425	14	195	51.2	4.90	5.3
425	15	130	33.4	6.49	32.5
Average:			35.1%		21.1%

TABLE 3, PAGE 2: MEAN ELAPSED TIME AND CORRECT RATE, AND CHANGES IN THESE, BY CLASS AND STUDENT

Again, the normal students showed considerably less change, on a book to book basis for selected students, than learning disabled students, with the average change (combining elapsed time and correct rate) being 28.1% for the former and 51.6% for the latter. Normal students showed a change of more than 30% in either of the two measures on 19 out of 46 opportunities (or 41.3% of these opportunities), while learning disabled students showed a change of more than 30% on 12 out of 20 opportunities (or 60.0% of these opportunities).

Comparison of Table 2 with Table 3 shows that absolute scores for elapsed time and correct rate showed much more change, from book to book for selected students, than did quartile ranking changes. The average percentage change for these two measures was 3.97 times as large for absolute scores as for quartile rankings, in the case of learning disabled students. For normal students, the average percentage change for these two measures was 5.85 times as large for absolute scores as for quartile rankings.

Table 4 presents changes in quartile rankings for correct rate and elapsed time within a given book (in this case book 13) for selected students from class two. The purpose of this table is to show that there is little change in quartile rankings, for individual students, in relation to performance throughout a given book. This corresponds to the finding of stability in quartile rankings across books, particularly for the normal students.

It will be noted that the data for the eight students presented in Table 4 shows considerable stability, particularly for Students 410, 415, 416, and 418. For example, Student 418 has mean quartile rankings, for correct rate, of 3.3, 3.0, and 3.0 respectively, for the first 50, the second 50, and the last 28 pages in book 13. The same student has mean quartile rankings, for elapsed time, of 3.0, 2.9, and 2.9 respectively, for the first 50, the second 50, and the last 28 pages in the same book. Only Students 420 and 422 show any appreciable changes and these are not major. For example, Student 420 shows a change of 0.5 quartile rankings from the first 50 to the second 50 pages in book 13, and a change of 0.6 quartile rankings from the second 50 to the last 28 pages in the same book, in regard to correct rate. In regard to elapsed time, the same student shows a change of 0.4 quartile rankings from the first 50 to the second 50 pages in book 13, and a change of 0.6 quartile rankings from the second 50 to the last 28 pages in the same book.

B. The Predictive Model

As mentioned in the Objectives section, there are many variables which can be used in an equation or series of equations designed to predict performance on instructional materials. In the present project a very simple predictive equation was utilized, one which contained only a few variables. In order to construct the equation one need know only the following information (focusing here on correct rate):

1. The average correct rate of the individual student's reference group (the reference group is composed of students whose characteristics are similar to those for the student whose performance we are trying to predict. These characteristics may

S# (Book 13)	Mean QR-CR 1st 50pp	Mean QR-CR 2nd 50pp	Mean QR-CR last 28pp	Mean QR-ET 1st 50pp	Mean QR-ET 2nd 50pp	Mean QR-ET last 28pp
407	0.7	0.6	0.4	0.7	0.5	0.4
410	3.9	4.3	3.9	4.2	4.5	4.1
415	2.2	2.3	-	2.1	2.2	-
416	2.7	2.8	3.2	2.6	2.6	3.0
418	3.3	3.0	3.0	3.0	2.9	2.9
420	1.2	1.7	2.3	1.2	1.6	2.2
422	2.0	2.0	1.5	1.9	2.1	1.4
423	3.0	3.4	2.6	2.9	3.4	2.7

TABLE 4: CHANGES IN QUARTILE RANKINGS WITHIN A GIVEN BOOK

be the students' age, sex, performance on related materials, performance on standardized tests, other measures, or a combination of measures) on the last book which the individual student has completed.

2. the correct rate of the individual student's reference group on upcoming pages or books (i.e., the pages or books on which we are trying to predict the individual's performance).

3. the differences between 1. and 2., noting the direction of the difference (i.e., was there an increase or a decrease from 1. to 2.?). For purposes of the predictive equation, this difference is divided by five (5), since this corrected fairly well for the fact that, in some instances, when a few students in the reference group had extreme scores, this led to considerable skewing of the averaged measures for the group.

4. the correct rate of the individual student on the last book he or she completed.

5. the interquartile rank of the individual student on the last book he or she completed.

Given the preceding information, in addition to the basic assumption that the individual student will have the same interquartile rank on the upcoming book as he or she had on the previous book in relation to the performance measured, we are ready to proceed to the implementation of the predictive equation.

Assume that the student whose performance we are trying to predict had a quartile ranking on his or her last book of 2.74. We will then assume that this student's quartile ranking on the upcoming book will also be 2.74. The next step is to secure the Book Completion Report Across Students, Type 2 (see Appendix E) for the book in which we are going to predict the student's performance. This report lists, for both elapsed time and correct rate (error rate may also be listed, but was not during the current project), the average minimum, first quartile, median, third quartile, and maximum scores for the entire book, as well as for each of the pages in the book.

Assuming a predicted quartile rank for our student of interest of 2.74, we determine what correct rate is represented by quartile ranking of 2.74. This calculation is made possible by the fact that we have print-outs of the average (for the book) first quartile, median, third quartile scores, etc. Interpolation is required when the student's anticipated quartile rank is not exactly 1.0, 2.0, e.0, or 4.0.

Tables 5 through 8 present predicted elapsed times and correct rates for students selected at random from the two classes.

Book #	Class #	Mean-Median ET	Diff. Bet. This & Next Book ET	S#	Actual Mean ET(sec)	Actual Mean QR-ET	Predicted Mean QR-ET	Predicted Mean ET	Last Book off by (%)	Prediction off by (%)
13	2	85.2	(+54.8)	407	50.0	3.97	--	--	--	--
14	2	140.0	(-52.6)	407	82.0	4.18	3.97	89.1	39.0	8.7
15	2	87.4	(+8.2)	407	53.0	4.11	4.18	39.3	54.7	25.9
16	2	95.6		407	52.0	3.88	4.11	49.8	1.9	4.2
13	2			420	77.0	2.92	--	--	--	--
14	2			420	115.0	3.14	2.92	110.2	33.0	4.2
15	2			420	67.0	3.49	3.14	46.6	71.6	30.5
16	2			420	49.0	4.14	3.49	49.8	36.6	1.8
13	2			423	129.0	1.70	--	--	--	--
14	2			423	178.0	1.90	1.70	167.9	27.5	5.7
15	2			423	126.0	1.42	1.90	80.5	38.1	36.1
16	2			423	130.0	1.13	1.42	119.7	3.1	7.9
									Ave= 33.9%	Ave= 13.6%

TABLE 5: PREDICTED ELAPSED TIME AND RELATED DATA, CLASS TWO

Book #	Class #	Mean-Median CR	Diff. Bet. This & Next book-CR	S#	Actual Mean CR	Actual Mean QR-CR	Predicted Mean QR-CR	Predicted Mean CR	Last Book off by (%)	Prediction off by (%)
13	2	6.09	(-0.92)	423	5.10	1.75	--	--	--	--
14	2	5.17	(+1.56)	423	4.79	1.96	1.75	4.64	6.5	3.1
15	2	6.73	(+0.92)	423	5.39	1.62	1.96	6.96	11.1	29.1
16	2	7.65		423	5.32	1.46	1.62	6.82	1.3	28.2
13	2			420	7.45	2.88	--	--	--	--
14	2			420	6.90	2.93	2.88	7.23	7.9	4.8
15	2			420	9.69	3.33	2.93	10.05	29.1	3.8
16	2			420	14.69	3.86	3.33	14.83	34.4	1.0
13	2			407	12.53	3.84	--	--	--	--
14	2			407	10.08	4.11	3.84	10.24	24.3	1.6
15	2			407	12.86	3.99	4.11	13.93	21.6	8.3
16	2			407	12.53	3.73	3.99	15.36	2.8	22.6
									Ave= 15.4%	Ave= 11.4%

TABLE 6: PREDICTED CORRECT RATE AND RELATED DATA, CLASS TWO

Book #	Class #	Median ET	Diff. Bet. This & Next book-ET	S#	Actual Mean ET	Actual Mean QR-ET	Predicted Mean QR-ET	Predicted Mean ET	Last Book off by (%)	Prediction off by (%)
14	1	144.9	(-28.0)	205	159.0	2.70	--	--	--	--
15	1	116.9	(+30.9)	205	66.0	4.17	2.70	98.4	140.9	49.1
16	1	137.8	(-)	205	162.0	2.37	4.17	86.2	59.2	46.7
13	1	85.4	(+59.5)	307	129.0	1.68	--	--	--	--
14	1	144.9	(-28.0)	307	204.0	1.84	1.68	207.1	36.7	1.5
15	1	116.9	(-)	307	104.0	3.04	1.84	191.4	96.1	84.0
13	1	85.4	(+59.5)	308	90.0	2.62	--	--	--	--
14	1	144.9	(-28.0)	308	130.0	3.27	2.62	139.7	30.8	7.5
15	1	116.9	(-)	308	113.0	2.96	3.27	63.0	15.0	44.2
									Ave= 63.1%	Ave= 38.8%

TABLE 7: PREDICTED ELAPSED TIME AND RELATED DATA, CLASS ONE

Book #	Class #	Mean-Median CR	Diff. Bet. This & Next book-CR	S#	Actual Mean CR	Actual Mean QR-CR	Predicted Mean QR-CR	Predicted Mean CR	Last Book off by (%)	Prediction off by (%)
14	1	5.06	(+0.31)	205	5.07	2.60	--	--	--	--
15	1	5.37	(-0.82)	205	11.04	3.96	2.60	7.24	54.1	34.4
16	1	4.55	(-)	205	5.45	2.49	3.96	8.89	102.6	63.1
13	1	6.42	(-1.36)	307	5.46	1.66	--	--	--	--
14	1	5.06	(+0.31)	307	4.24	1.74	1.66	4.22	28.8	0.5
15	1	5.37	(-)	307	6.47	2.93	1.74	4.84	34.5	25.2
13	1	6.42	(-1.36)	308	6.64	2.57	--	--	--	--
14	1	5.06	(+0.31)	308	6.37	3.22	2.57	6.76	4.2	6.1
15	1	5.37	(-)	308	7.02	2.93	3.22	6.44	9.2	8.3
									Ave= 38.9%	Ave= 22.9%

TABLE 8: PREDICTED CORRECT RATE AND RELATED DATA, CLASS ONE

Table 5 shows that, using the formula just described, our predictions were, on the average, within less than 14% of the actual elapsed times for class two. If we use the students' average elapsed time on the previous book to predict their performance on the next book our estimates are off, on the average, by 33.9% for class two. It should be noted that there is a constant underestimation of elapsed time on book 15 for the three selected students. For these students, our predictions, using the formula, are off by 25.9%, 30.5%, and 36.1%, respectively. If this error were found to be maintained across many students on this book, a constant factor could be added to the predicted elapsed time, which would bring the average error in prediction to approximately five to eight percent.

Table 6 shows that, using the formula, our predictions were, on the average, within less than 12% of the actual correct rates for class two. If we use the students' average correct rates on the previous book to predict their performance on the next book our estimates are off, on the average, by 15.4%. It should be noted that one student contributed very heavily to the average deviation from predicted scores.

For class one, the learning disabled students, our predictive equation was less accurate than for the normal students. Table 7 shows that the prediction for elapsed time was off, on the average, 38.8% (compared to 13.9% for the normal class). Using the students' elapsed time on the previous book as a predictor of performance on the upcoming book produced an average error of 63.1%. Table 8 shows that the prediction for correct rate of the learning disabled students was off, on the average, 22.9% (compared to 11.4% for the normal class). Using the students' correct rate on the previous book produced an average error of prediction of 38.9%.

For both the learning disabled and the normal students, predictions of correct rate were more accurate than predictions for elapsed time. This difference was especially pronounced for the learning disabled students.

C. Comparisons Between Normal and Learning Disabled Students

As mentioned in part A. of this section and presented in Table 1, the normal students performed better than the learning disabled students on an average of five of every six measures for those books for which data was available for both classes.

Figure 5 depicts mean-median elapsed times for all books for which data is available for both classes.

Examination of Figure 5 shows that the differences in mean-median elapsed time between class one and two increase progressively after book 14, with class two being superior to class one in each book except book 5.

Figure 6 depicts the mean-median correct rates for all books for which data is available for both classes.

Figure 6 shows very clearly the progressive increase in differences in mean-median correct rate after book 14, analogous to that shown in regard to elapsed time in Figure 5. Again the normal students are superior to the learning disabled students, except on book 13.

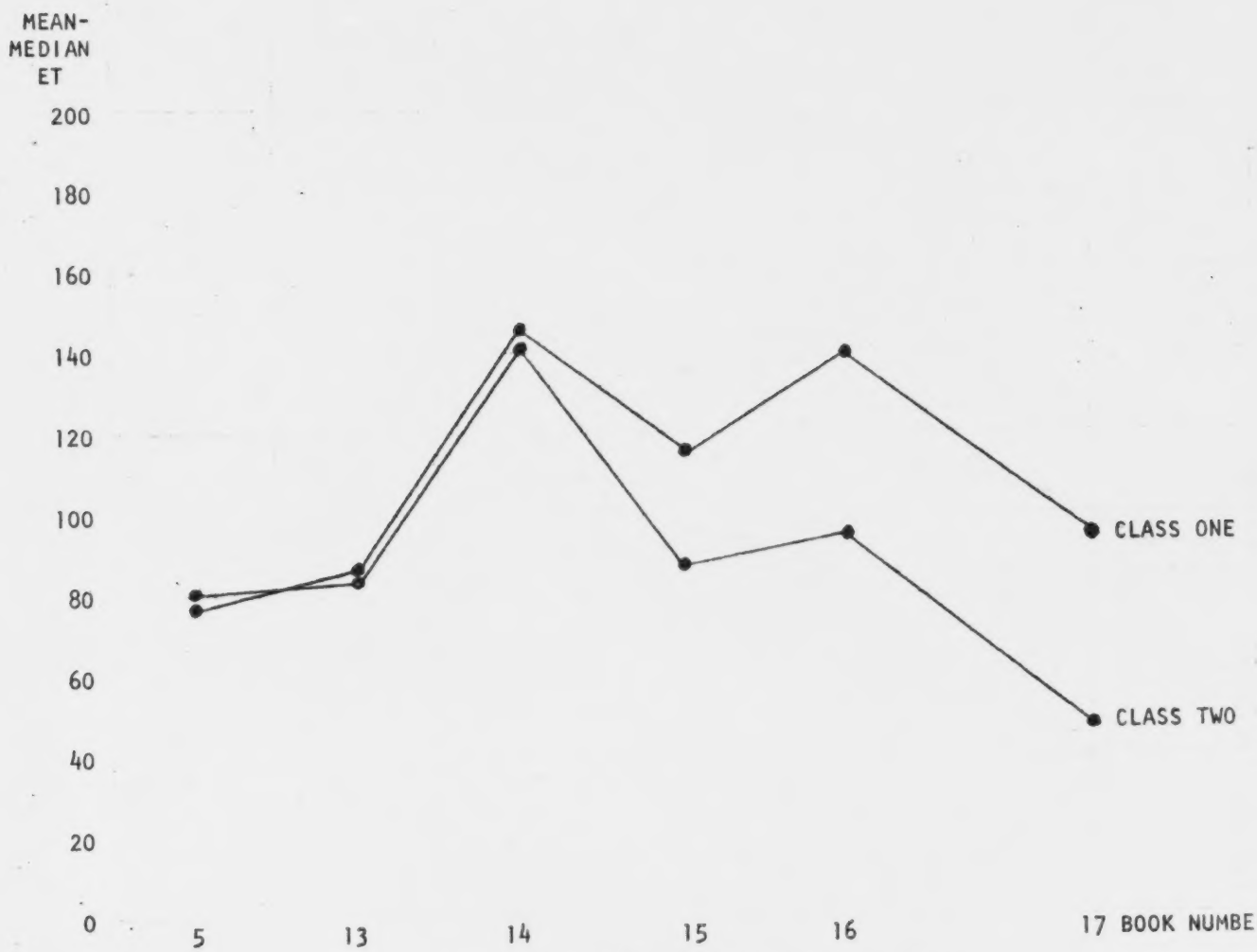
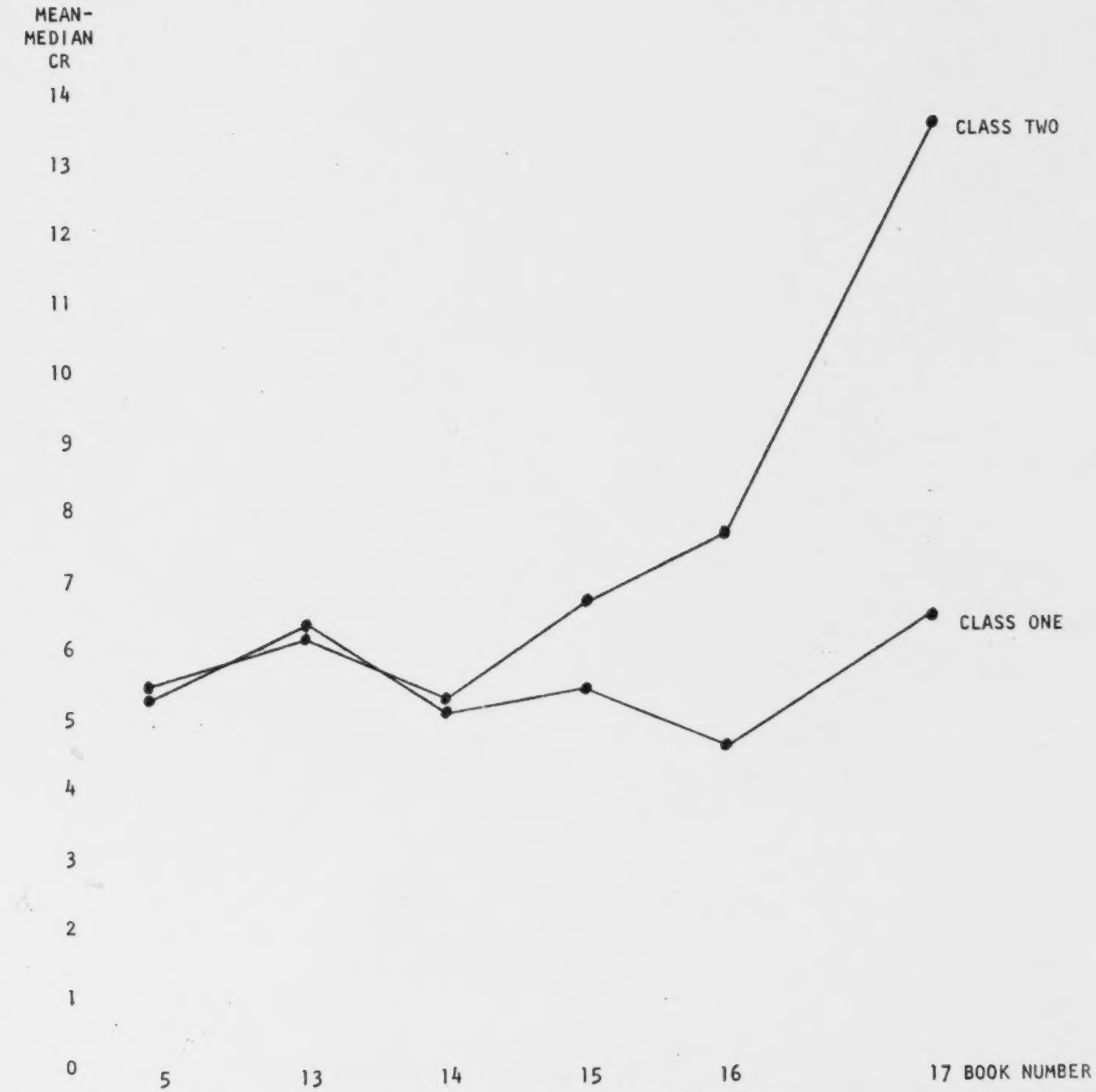


FIGURE 5: MEAN-MEDIAN ELAPSED TIMES



32

FIGURE 6: MEAN-MEDIAN CORRECT RATES

DISCUSSION AND CONCLUSIONS

The Pupil Performance Profile, to date, has had little more than a preliminary development. The results so far are only a gross approximation of the conciseness and precision which eventually should be possible utilizing this approach. However, even relying solely on the capabilities of the present system, considerable information may be made available for decision-making by teachers, administrators, parents, and students.

The present capabilities of the system are as follows:

(a) the determination of student performance on three major measures by class or type of student;

(b) the determination of performance on each measure by individual student;

(c) the relationship of individual students' performances to that of their reference group (i.e., those in the same class and/or of the same type; e.g., learning disabled, normal, brain-damaged, physically handicapped);

(d) the distribution of student performance by quartile ranking; this enables the determination of the range of scores which encompass 25%, 50%, or 75% of all students on each page in every book and for each book as a whole;

(e) the prediction of student performance, using the predictive formula discussed in the Results section.

For the purposes of this pilot project, fine-grain data was gathered and printed out for every student on every page on which he or she worked. In actual classroom application, however, while continuous measurement and recording would be maintained, the type, frequency, and amount of print-outs could be reduced sharply without loss of effectiveness and with considerable gain in efficiency. For example, instead of presenting teachers with complete print-outs, by page and by book for each student (see Appendix C), a print-out could be presented which indicated only the student's average data for the measures of interest. Then, if the data so indicated, a complete print-out could be requested. This capsule summary would allow a teacher or administrator to scan but one or two pages in order to determine how all students are performing. The same condensation tactic may be used in regard to other reports, such as student performance by class quartile rankings, (see Appendix E).

In similar fashion, separate print-outs of predicted performance, by page and/or by book, could be made available so that decision-makers could be alerted to the likelihood of deficient performance and be provided with sufficient lead time to deal with these situations.

Overall, the relative performance of the two classes of students was as expected. The superiority of the normal students, despite the fact that their mean age was several years less than the learning disabled students, came as no surprise. Some of the criteria for classifying students as learning disabled are inattentiveness, lack of concentration, and the existence of competing behaviors; e.g., out-of-seat, talk-outs, which are incompatible with high-level academic performance. The learning disabled students are not, on either an inter- or an intra-student basis, uniformly poor performers. Rather, their performance is erratic, ranging from scores which equal or exceed the normal students on certain pages and for certain books, to scores which are abysmally low.

Indeed, for both classes, there was an inverse relationship between variability in performance within and across books and overall level of performance. That is, the best students showed the most consistency, the better (but not best) students were less consistent than the best students, but more consistent than the poorer students, and so on. The worst students were the least consistent. The implication of this finding is that predictions of the performance of poorer students will, on the average, be less accurate than predictions of the performance of better students.

Offsetting the previous observation is the fact that, in the current study, despite considerable fluctuations in scores of individual students from one book to the next, students tended to fluctuate at the same points. Take the case of a student who had a correct rate on book 13 of 8.0 per minute, followed by correct rates of 17.0 and 6.8 on books 14 and 15, respectively. This degree of variability from book to book would make prediction quite difficult, were it not for the fact that, lumping all students of a given class or type, their averaged scores across these same books changed in the same direction as that of the individual student.

The individual student's quartile rank, by page and averaged across an entire book, because of its demonstrated stability (e.g., average changes for normal students of approximately five percent from book to book for selected students), makes for accurate prediction. This is the case despite the very elementary nature of the predictive formula. In the future, the formula could be expanded to include the following:

(a) past performance across more than one book and trends in past performance;

(b) the history of the accuracy of past predictions;

(c) the inclusion of other variables in the formula;

(d) the determination of appropriate weighting factors for the variables used;

(e) the development of sub-formulas which are accurate predictors of the performance of individuals or small groups of students, rather than using a universal formula applied to all students;

(f) provision for predictions which cover a range of values, e.g., a correct rate of 6.2 to 7.5;

(g) provision for stating the probability of correctly predicting a score; e.g., predicting, with a probability of .05, an average correct rate on book 22 of 9.1, with a range from 7.8 to 10.3.

Difficulties Encountered in Carrying Out Research

The major difficulty encountered in carrying out the research stemmed from the issuance of a directive which precluded the use of students at the Experimental Education Unit, CDMRC. The denial of these students forced a change in locale to the Mercer View School, Mercer Island, Washington. In the time available, it was not possible to secure the range of student characteristics, the precise matching of students, nor the degree of experimental control which would have pertained had the project been carried out at the Experimental Education Unit.

The original experimental design included the use of different treatment conditions with students of similar characteristics, and the application of the same treatment to students of different characteristics. This design would have provided precise comparative data which would have enabled us to make at least a gross determination of the degree of contribution of several factors, including the student, the instructional materials, and the behavior management procedures, to student performance. Instead, we were limited, primarily by lack of time, but also by manpower (since working in Mercer Island required far greater expenditures for travel and consumed much time), to the use of one class of normal students (second grade) and one class of learning disabled students (ages six to eleven). As a result, it was not possible to make detailed comparative assessments of the contributions to performance of the aforementioned three elements.

However, the principal investigator still strongly feels that such an approach is feasible and will yield worthwhile results.

Probably the most important problem was the failure of our initial computer programmer to fulfill his obligations. As a result, a delay of several months was encountered until his duties were taken over by someone else. Whereas the computer was supposed to have been programmed to handle predictions of student performance, it became necessary, as a result of this delay, to work the predictions by hand. Thus we had considerably less opportunity to test the formula and almost no chance to make it more sophisticated and effective.

The other significant problem was an inherent part of the project itself, and, as such, could not have been avoided. This refers to the extreme difficulty of determining, in advance, the cost of carrying out various mathematical operations by computer. As the project progressed, we were far better able to predict what our costs would be and hence were able to stay within the budget.

SUMMARY AND RECOMMENDATIONS

This project accomplished most of what it proposed to do, with the exception of providing comparative data concerning the relative contributions to performance of student characteristics, instructional materials, and behavior management procedures (the reason for not accomplishing the latter objective is presented in the previous section). The project has resulted in the initial development of an objective system for evaluating and describing student performance, as well as for predicting performance.

The cost of installing and operating such a system on a mass basis, once it becomes fully operational, should be low. Any school or school district which has teletype access to a computer will be able to participate in this activity. Perhaps the major hurdle will be the development of more efficient procedures for scoring student responses and for transferring the responses to punch cards or other media. It is possible that instructional materials may be developed which provide for responses which can be read by the computer itself. But even without this degree of sophistication, it should be possible to find, at low cost, students or aides who would serve as data recorders.

The current project's principal investigator plans to expand the project to include a wide range of types of students, instructional materials, and behavior management procedures. This phase of the research, which will require approximately three years for completion, will be preliminary to actual implementation on a large scale basis.

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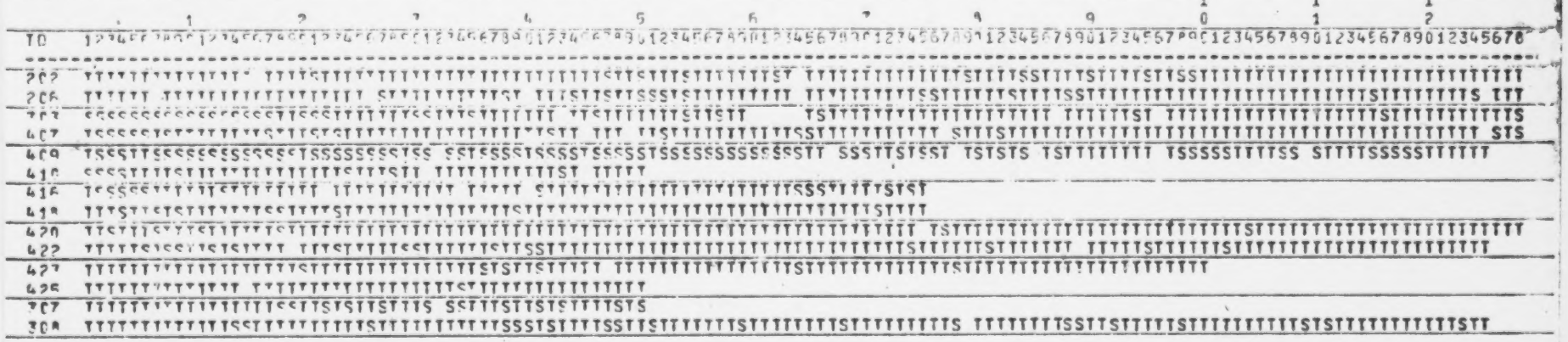
APPENDIX A

Student Ident. Number	BRL Book Number	Page Number in Book	# Items Correct	# Items Incorrect	# Items Incomplete	Start Time	Stop Time

APPENDIX B

*****STATUS REPORT FOR BOOK 13***** 11/20/71



APPENDIX C

****** BOOK COMPLETION REPORT ******

******ERIN MAJURY 413 BOOK 5 06/04/72

PAGE	CORRECT	INCORRECT	INCOMPLETE	QUALITY	EFFICIENCY	TIME	C-RATE	E-RATE		
1	4	0	0	100.0	100.0	1:30	2.67	0.00	2	00
2	5	0	0	100.0	100.0	NO DATA				
3	8	0	0	100.0	100.0	1:45	4.57	0.00	2	00
4	8	0	0	100.0	100.0	2:20	3.43	0.00	2	02
5	5	0	0	100.0	100.0	1:35	3.16	0.00	2	02
6	5	0	0	100.0	100.0	0:55	5.45	0.00	1	05
7	8	0	0	100.0	100.0	NO DATA				
8	7	1	0	87.5	87.5	NO DATA				
9	5	0	0	100.0	100.0	0:55	5.45	0.00	2	02
10	5	0	0	100.0	100.0	0:50	6.00	0.00	2	00
11	NO DATA									
12	8	0	0	100.0	100.0	1:55	4.17	0.00	2	05
13	5	0	0	100.0	100.0	1:45	2.86	0.00	2	00
14	3	2	0	60.0	60.0	0:35	5.14	3.43*****	2	55
15	4	0	0	100.0	100.0	0:30	8.00	0.00	1	05
16	NO DATA									
17	4	1	0	80.0	80.0	0:50	4.80	1.20	2	00
18	4	0	0	100.0	100.0	1: 0	4.00	0.00	2	00
19	5	0	0	100.0	100.0	1:20	3.75	0.00	2	00
20	5	0	0	100.0	100.0	1: 5	4.62	0.00	2	00
21	7	0	0	100.0	100.0	2:15	3.11	0.00	2	00
22	8	0	0	100.0	100.0	1: 0	8.00	0.00	2	00
23	8	0	0	100.0	100.0	0:50	9.60***	0.00	2	55
24	5	0	0	100.0	100.0	1:28	3.41	0.00	2	02
25	5	0	0	100.0	100.0	1:10	4.29	0.00	2	00
26	4	0	0	100.0	100.0	1:30	2.67	0.00	2	00
27	4	1	0	80.0	80.0	1:45	2.29	.57	2	00
28	5	0	0	100.0	100.0	1:45	2.86	0.00	1	05
29	5	0	0	100.0	100.0	1:25	3.53	0.00	2	02
30	8	0	0	100.0	100.0	2:55	2.74	0.00	2	02
31	7	1	0	87.5	87.5	1:30	4.67	.67	1	05
32	5	0	0	100.0	100.0	1:25	3.53	0.00	2	02
33	5	0	0	100.0	100.0	1:10	4.29	0.00	2	00
34	4	0	0	100.0	100.0	NO DATA				
35	4	1	0	80.0	80.0	1:30	2.67	.67	2	00
36	5	0	0	100.0	100.0	NO DATA				
37	7	0	0	100.0	100.0	2:40	2.63	0.00	2	00
38	8	0	0	100.0	100.0	0:55	8.73**	0.00	2	55
39	5	0	0	100.0	100.0	1: 0	5.00	0.00	2	00
40	5	0	0	100.0	100.0	2: 5	2.40	0.00	2	00
41	4	0	0	100.0	100.0	1: 5	3.69	0.00	2	55
42	5	0	0	100.0	100.0	2:10	2.31	0.00	2	00
43	5	0	0	100.0	100.0	1:40	3.00	0.00	2	00
44	7	0	0	100.0	100.0	2:20	3.00	0.00	2	05
45	8	0	0	100.0	100.0	0:30	16.00*****	0.00	2	55
46	8	0	0	100.0	100.0	1:35	5.05	0.00	1	05
47	4	1	0	80.0	80.0	2:40	1.50	.38	2	00
48	5	0	0	100.0	100.0	2:15	2.22	0.00	1	05
49	4	0	0	100.0	100.0	1:15	3.20	0.00	2	00
50	5	0	0	100.0	100.0	1:10	4.29	0.00	2	00

****** BOOK COMPLETION REPORT ******

****** ERIN MAJOR ****** 413 BOOK 5 08/04/72

PAGE		CORRECT	INCORRECT	INCOMPLETE	QUALITY	EFFICIENCY	TIME	C-RATE	E-RATE		
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53	NO DATA										
54		7	1	0	87.5	87.5	1:20	5.25	.75	2	00
55		5	0	0	100.0	100.0	0:55	5.45	0.00	1	05
56		4	1	0	80.0	80.0	1:35	2.53	.63	2	02
57		4	0	0	100.0	100.0	1:15	3.20	0.00	2	00
58		5	0	0	100.0	100.0	1:30	3.33	0.00	1	05
59	NO DATA										
60		6	1	0	85.7	85.7	3:40	1.64	.27	1	05
61		7	1	0	87.5	87.5	2:50	2.47	.35	2	00
62		7	1	0	87.5	87.5	1:55	3.65	.52	1	05
63		5	3	0	62.5	62.5	2:25	2.07	1.24*	1	05
64	TEST	8	2	0	80.0	80.0	NO DATA				
65		5	0	0	100.0	100.0	1:45	2.86	0.00	2	00
66		4	1	0	80.0	80.0	1:40	2.40	.60	2	00
67		5	0	0	100.0	100.0	2:20	2.14	0.00	2	00
68		8	0	0	100.0	100.0	1:45	4.57	0.00	2	00
69		7	1	0	87.5	87.5	1:20	5.25	.75	2	00
70		7	1	0	87.5	87.5	2:40	2.63	.38	2	00
71		4	0	0	100.0	100.0	1:20	3.00	0.00	2	05
72		5	0	0	100.0	100.0	1:20	3.75	0.00	2	00
73		5	0	0	100.0	100.0	1:20	3.75	0.00	2	00
74		4	0	0	100.0	100.0	0:50	4.80	0.00	2	00
75		5	0	0	100.0	100.0	NO DATA				
76		5	0	0	100.0	100.0	1:25	3.53	0.00	2	02
77	NO DATA										
78		8	0	0	100.0	100.0	2: 5	3.84	0.00	2	02
79		5	0	0	100.0	100.0	1:55	2.61	0.00	2	00
80		4	1	0	80.0	80.0	1: 5	3.69	.92	2	02
81		5	0	0	100.0	100.0	2:20	2.14	0.00	2	00
82		5	0	0	100.0	100.0	1: 5	4.62	0.00	2	55
83		4	1	0	80.0	80.0	1:20	3.00	.75	2	00
84		7	0	0	100.0	100.0	1:10	6.00	0.00	2	55
85		7	1	0	87.5	87.5	1:55	3.65	.52	2	00
86		8	0	0	100.0	100.0	1:10	6.86	0.00	2	55
87		5	0	0	100.0	100.0	1: 5	4.62	0.00	2	00
88		5	0	0	100.0	100.0	1:25	3.53	0.00	2	02
89		5	0	0	100.0	100.0	1:20	3.75	0.00	2	00
90		5	0	0	100.0	100.0	1:20	3.75	0.00	2	00
91		5	0	0	100.0	100.0	1:55	2.61	0.00	2	00
92		7	0	0	100.0	100.0	1:40	4.20	0.00	2	00
93		6	2	0	75.0	75.0	2: 0	3.00	1.00	2	00
94		7	1	0	87.5	87.5	1:35	4.42	.63	2	02
95		5	0	0	100.0	100.0	1:30	3.33	0.00	2	00
96		5	0	0	100.0	100.0	1:40	3.00	0.00	2	00
97		5	0	0	100.0	100.0	1:15	4.00	0.00	2	00
98		5	0	0	100.0	100.0	1:55	2.61	0.00	2	00
99		5	0	0	100.0	100.0	2:25	2.07	0.00	2	02
100		6	1	0	85.7	85.7	2:40	2.25	.38	2	00

******ERIN MAJURY 1413 ****** BOOK COMPLETION REPORT ****** BOOK 5 06/04/72

PAGE		CORRECT	INCORRECT	INCOMPLETE	QUALITY	EFFICIENCY	TIME	C-RATE	E-RATE		
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102		6	2	0	75.0	75.0	1:20	4.50	1.50***	2	00
103		4	1	0	80.0	80.0	1:30	2.67	.67	2	00
104		5	0	0	100.0	100.0	1:55	2.61	0.00	2	00
105		5	0	0	100.0	100.0	0:35	8.57*	0.00	2	55
106		4	1	0	80.0	80.0	1:35	2.53	.63	2	52
107		5	0	0	100.0	100.0	1:30	3.33	0.00	2	00
108		6	1	0	85.7	85.7	1:25	4.24	.71	2	55
109		7	1	0	87.5	87.5	1:10	6.00	.86	2	00
110		6	2	0	75.0	75.0	1:20	4.50	1.50**	2	55
111		5	0	0	100.0	100.0	1:15	4.00	0.00	2	05
112		5	0	0	100.0	100.0	1: 5	4.62	0.00	2	00
113		4	1	0	80.0	80.0	1:20	3.00	.75	2	00
114		5	0	0	100.0	100.0	2: 5	2.40	0.00	2	00
115		5	0	0	100.0	100.0	1:45	2.86	0.00	2	00
116		7	0	0	100.0	100.0	2: 5	3.36	0.00	2	00
117		7	1	0	87.5	87.5	2:15	3.11	.44	2	00
118		8	0	0	100.0	100.0	2:25	3.31	0.00	2	00
119		4	1	0	80.0	80.0	0:30	8.00	2.00****	2	55
120		4	1	0	80.0	80.0	2:25	1.66	.41	2	00
121		5	0	0	100.0	100.0	1: 0	5.00	0.00	2	55
122		4	1	0	80.0	80.0	2:25	1.66	.41	2	00
123		5	0	0	100.0	100.0	1:20	3.75	0.00	2	00
124		7	0	0	100.0	100.0	0:50	8.40	0.00	2	00
125		8	0	0	100.0	100.0	1:10	6.86	0.00	1	05
126		7	1	0	87.5	87.5	1:20	5.25	.75	2	00
127		8	0	0	100.0	100.0	1:25	5.65	0.00	2	02
128	TEST	9	1	0	90.0	90.0	NO DATA				
TOTALS(N=114)		635	39	0	94.2	94.2	177:48	3.57	.22		
AVERAGES					94.6	94.6	1:34	4.12	.24**	.66	1.64
(THE ABOVE IS FOR ONLY THOSE PAGES ON WHICH TIME WAS RECORDED)											
TOTALS(N=121)		676	40	0	94.4	94.4					
AVERAGES					94.8	94.8					

APPENDIX D

STUDY RESULTS FORMAT 1** BOOK 13 CLASS 2 06/04/72

AGE	N	TOTAL	AVERAGES RIGHT	WRONG	OMIT	QUALITY AVE	QUALITY SE	EFFICIENCY AVE	EFFICIENCY SE	N	ELAPSED TIME AVE	ELAPSED TIME SE	C-RATE AVE	C-RATE SE	E-RATE AVE	E-RATE SE
1	16	5	4.9	.1	0.0	97.5	9.7	97.5	9.7	14	1.6	.9	5.0	4.7	.3	1.0
2	16	8	7.8	.2	0.0	97.7	4.9	97.7	4.9	12	1.5	.8	7.1	3.9	.4	.7
3	16	8	7.8	.2	0.0	97.7	4.9	97.7	4.9	11	1.7	2.0	8.8	5.5	.5	1.0
4	16	10	9.9	.1	0.0	99.4	2.4	99.4	2.4	10	1.5	1.0	11.4	8.2	.2	.6
5	16	5	5.0	0.0	0.0	100.0	0.0	100.0	0.0	14	.8	.4	10.2	14.0	0.0	0.0
6	16	8	8.0	0.0	0.0	100.0	0.0	100.0	0.0	13	1.2	.8	9.0	4.7	0.0	0.0
7	16	8	8.0	0.0	0.0	100.0	0.0	100.0	0.0	13	1.9	1.1	6.1	4.3	0.0	0.0
8	16	10	9.9	0.0	.1	100.0	0.0	99.4	2.4	12	1.4	.8	9.5	5.0	0.0	0.0
9	16	8	7.9	.1	0.0	99.2	3.1	99.2	3.1	11	.9	.6	13.5	9.0	.4	1.1
10	16	10	10.0	0.0	0.0	100.0	0.0	100.0	0.0	12	1.2	.8	12.3	8.4	0.0	0.0
11	16	10	10.0	0.0	0.0	100.0	0.0	100.0	0.0	13	1.1	.6	12.6	6.9	0.0	0.0
12	16	8	7.5	.5	0.0	94.2	10.1	94.2	10.1	13	1.2	.6	10.3	11.4	.5	.8
13	16	8	7.9	.1	0.0	98.3	4.2	98.3	4.2	12	1.2	1.1	14.3	15.3	.1	.3
14	16	10	9.9	.1	0.0	99.3	2.5	99.3	2.5	13	1.2	.6	10.9	6.9	.1	.3
15	16	7	7.0	0.0	0.0	100.0	0.0	100.0	0.0	11	1.3	.9	8.9	5.6	0.0	0.0
16	16	10	10.0	0.0	0.0	100.0	0.0	100.0	0.0	14	.8	.3	14.2	6.2	0.0	0.0
17	16	10	10.0	0.0	0.0	100.0	0.0	100.0	0.0	12	1.4	.8	9.8	4.9	0.0	0.0
18	16	5	4.7	.3	.1	94.7	11.5	93.3	11.9	12	1.0	.5	5.5	2.2	.4	1.0
19	16	8	7.8	.2	0.0	97.5	5.0	97.5	5.0	11	1.5	1.0	7.4	3.3	.1	.3
20	16	10	9.9	.1	0.0	98.7	5.0	98.7	5.0	13	1.4	.9	10.6	6.3	.2	.6
21	16	10	9.9	.1	0.0	99.3	2.5	99.3	2.5	13	1.3	1.0	12.6	7.6	.1	.4
22	14	10	9.7	.1	.1	98.6	5.2	97.1	5.9	13	1.5	1.2	10.8	7.2	.4	.9
23	16	10	10.0	0.0	0.0	100.0	0.0	100.0	0.0	10	1.5	1.1	9.5	5.8	0.0	0.0
24	16	10	9.9	.1	0.0	99.3	2.5	99.3	2.5	12	1.5	.6	8.0	3.2	.0	.1
25	16	10	9.9	.1	0.0	98.7	5.0	98.7	5.0	13	1.1	.5	11.2	6.6	.2	.5
26	16	10	9.8	.2	0.0	98.0	4.0	98.0	4.0	13	1.5	.5	7.1	2.4	.1	.2
27	16	10	9.7	.3	0.0	96.7	4.7	96.7	4.7	14	1.4	.6	10.2	8.1	.5	1.1
28	16	10	9.9	.1	0.0	98.7	5.0	98.7	5.0	13	1.4	.7	8.7	3.4	.3	.9
29	16	5	4.5	0.0	.5	100.0	0.0	90.7	10.0	11	1.2	.8	7.1	5.7	.6	1.2
30	16	5	4.3	.1	0.0	98.7	5.0	98.7	5.0	13	1.1	.6	5.8	4.0	.1	.4
31	14	5	4.8	.2	0.0	95.7	11.2	95.7	11.2	12	1.2	.5	5.6	3.8	.2	.6
32	14	9	8.6	.4	0.0	96.0	8.0	96.0	8.0	13	2.1	1.0	5.7	4.0	.1	.4
33	16	9	8.6	.4	0.0	95.6	8.9	95.6	8.9	13	2.0	1.6	6.2	3.2	.2	.4
34	14	8	7.6	.4	0.0	94.6	10.3	94.6	10.3	11	1.7	.9	7.5	6.9	1.1	3.4
35	16	9	8.5	.5	0.0	94.1	9.0	94.1	9.0	13	2.1	1.0	5.1	2.9	.2	.4
36	16	9	8.5	.5	0.0	94.1	10.6	94.1	10.6	12	1.6	.6	6.1	2.6	.3	.5
37	14	8	7.9	.1	0.0	98.2	4.4	98.2	4.4	12	2.0	.9	4.6	2.0	.1	.3
38	16	9	8.9	.1	0.0	98.5	3.8	98.5	3.8	13	1.8	1.6	9.4	11.4	.5	1.6
39	16	9	8.5	.5	0.0	94.8	9.8	94.8	9.8	12	1.5	.6	7.8	5.6	1.1	3.3
40	14	8	7.1	.9	0.0	89.3	17.6	89.3	17.6	13	1.7	.8	5.8	3.7	1.0	2.5
41	16	9	8.6	.4	0.0	95.6	6.8	95.6	6.8	10	2.0	1.3	6.0	3.9	.4	.7
42	16	9	8.6	.4	0.0	95.6	9.8	95.6	9.8	13	1.9	1.7	6.4	3.2	.4	1.0
43	16	8	7.5	.5	0.0	94.2	10.1	94.2	10.1	13	2.1	1.0	4.6	2.9	.4	.6
44	16	9	8.4	.6	0.0	93.3	11.3	93.3	11.3	13	2.0	1.1	6.4	4.3	.5	1.1
45	13	9	8.8	.2	0.0	97.4	6.4	97.4	6.4	12	2.1	1.4	5.4	2.3	.1	.5
46	16	8	7.3	.7	0.0	90.8	12.5	90.8	12.5	14	2.3	1.9	4.9	3.4	.5	.8
47	14	9	8.6	.4	0.0	96.0	9.0	96.0	9.0	12	1.6	1.0	6.4	2.4	.4	.9
48	16	9	8.3	.7	0.0	92.6	14.4	92.6	14.4	13	2.0	1.2	5.5	2.6	.6	1.8
49	14	8	7.6	.4	0.0	94.6	9.1	94.6	9.1	13	2.1	1.1	5.4	4.5	.5	1.6
50	16	9	8.5	.4	.1	95.6	7.9	94.8	8.0	14	1.8	.8	5.8	2.5	.6	.9
51	16	9	8.5	.5	0.0	94.1	10.6	94.1	10.6	14	1.5	.6	7.4	4.8	.8	1.7

****PRR REPORT FORMAT 1**** BOOK 13 CLASS 2 06/04/72

PAGE	N	TOTAL	AVERAGES RIGHT	WRONG	OMIT	QUALITY AVE	QUALITY SE	EFFICIENCY AVE	EFFICIENCY SE	N	ELAPSED TIME AVE	ELAPSED TIME SE	C-RATE AVE	C-RATE SE	E-RATE AVE	E-RATE SE
52	15	8	7.7	.3	0.0	96.7	5.5	96.7	5.5	12	2.2	1.0	6.8	10.7	.6	1.6
53	15	9	8.4	.6	0.0	93.3	9.8	93.3	9.8	12	1.8	1.0	8.5	10.3	1.2	3.3
54	15	9	8.4	.6	0.0	93.3	10.6	93.3	10.6	14	2.0	1.0	5.9	3.8	.5	1.2
55	15	10	9.7	.3	0.0	96.7	6.0	96.7	6.0	13	2.1	1.6	7.0	4.3	.3	.6
56	15	8	7.3	.7	0.0	91.7	14.2	91.7	14.2	13	1.7	1.0	7.3	6.1	1.3	4.2
57	15	8	7.5	.5	0.0	94.2	12.8	94.2	12.8	13	2.0	1.5	8.6	11.7	3.7	12.8
58	15	8	7.9	.1	0.0	99.2	3.1	99.2	3.1	14	1.6	.8	6.7	3.4	.1	.5
59	14	10	9.3	.7	0.0	92.9	12.8	92.9	12.8	11	2.1	1.6	7.3	5.3	.1	.3
60	14	10	9.6	.4	0.0	95.7	11.2	95.7	11.2	11	1.4	.6	8.5	4.7	.1	.4
61	15	8	7.5	.5	0.0	94.2	10.1	94.2	10.1	13	1.6	.7	5.4	2.1	.5	.8
62	15	10	9.9	.1	0.0	99.3	2.5	99.3	2.5	14	1.8	1.2	7.3	3.7	.1	.4
63	14	9	8.3	.5	.1	92.9	13.7	92.1	13.6	12	1.3	.6	7.5	4.0	.9	1.5
64	15	20	19.0	.9	.1	95.3	5.6	95.0	5.8	9	3.0	2.2	9.2	5.1	.4	.8
65	15	9	9.8	.2	0.0	97.8	6.0	97.8	6.0	13	1.9	.9	6.0	3.9	.2	.4
66	15	10	9.3	.7	0.0	93.3	8.7	93.3	8.7	12	2.0	1.0	6.3	3.9	.4	.8
67	13	9	8.5	.4	.1	95.5	8.7	94.9	10.3	9	2.1	1.5	6.4	4.0	0.0	0.0
68	15	10	9.2	.7	.1	92.7	13.9	92.0	13.8	14	1.6	1.1	10.9	9.9	1.5	4.2
69	15	10	9.5	.4	0.0	96.0	8.0	96.0	8.0	13	2.0	.8	5.6	2.3	.4	1.1
70	15	5	4.2	.3	.5	93.3	14.3	84.0	18.2	12	1.5	.9	5.0	5.1	1.3	1.8
71	15	8	7.7	.3	0.0	96.7	5.5	96.7	5.5	14	1.3	.7	11.1	12.4	.3	.4
72	15	9	8.4	.6	0.0	93.3	14.5	93.3	14.5	13	2.0	1.4	5.8	2.6	.2	.4
73	15	9	8.5	.5	0.0	94.1	6.9	94.1	6.9	13	2.1	1.5	5.9	3.7	.3	.5
74	15	9	8.5	.5	.1	94.8	9.8	94.1	9.8	11	1.5	.9	7.7	4.3	.6	1.5
75	12	8	7.0	1.0	0.0	87.5	19.1	87.5	19.1	11	1.8	1.7	5.7	3.0	1.2	2.1
76	12	9	7.8	.3	0.0	96.9	7.4	96.9	7.4	11	1.4	.7	8.9	8.8	1.2	3.4
77	12	10	9.7	.3	0.0	96.7	6.2	96.7	6.2	10	1.6	.4	6.4	1.5	.3	.6
78	12	10	9.3	.8	0.0	92.5	10.9	92.5	10.9	9	2.0	.5	4.9	1.2	.5	.9
79	13	5	4.1	.4	.5	91.9	15.1	81.5	14.5	9	1.7	1.2	4.2	3.1	1.0	1.2
80	13	8	7.3	.2	0.0	98.1	4.5	98.1	4.5	11	1.5	.6	6.5	3.6	.1	.3
81	13	9	8.7	.2	.1	97.4	6.4	96.5	5.7	12	1.1	.7	12.8	8.2	.8	2.2
82	13	10	9.6	.4	0.0	96.2	7.4	96.2	7.4	10	2.2	1.1	5.6	3.1	.5	.8
83	13	4	3.2	.2	.6	95.5	10.6	80.8	14.4	12	1.1	.7	4.5	3.1	1.7	3.2
84	13	8	7.7	.3	0.0	96.2	7.6	96.2	7.6	10	1.2	.6	8.1	3.7	.5	.7
85	12	9	8.8	.1	.1	99.1	3.1	98.1	4.1	12	1.9	1.2	7.9	7.9	.4	1.1
86	13	4	3.2	.1	.7	97.4	8.9	80.8	14.4	11	1.2	.9	5.0	3.5	1.4	1.4
87	13	10	9.7	.2	.1	97.7	4.2	96.9	4.6	12	2.0	1.5	8.6	7.4	.2	.3
88	13	4	3.5	.4	0.0	90.4	12.2	90.4	12.2	11	1.0	.8	8.3	12.8	.5	.6
89	13	10	9.2	.8	.1	92.2	11.2	91.5	11.7	12	1.9	.9	5.7	1.9	.8	1.2
90	13	4	3.4	.2	0.0	96.2	9.0	96.2	9.0	13	1.2	1.0	4.7	2.3	.2	.4
91	13	10	9.5	.5	0.0	94.6	8.4	94.6	8.4	12	1.8	1.0	7.0	3.5	.3	.5
92	13	9	9.3	.1	0.0	97.4	8.9	97.4	8.9	9	1.1	.8	5.0	4.9	.2	.5
93	13	10	9.2	.8	0.0	91.5	11.0	91.5	11.0	13	2.0	1.5	5.1	2.6	.7	1.2
94	13	5	4.6	.4	0.0	92.3	12.5	92.3	12.5	12	1.2	.7	6.1	4.9	.3	.6
95	13	10	9.2	.8	0.0	92.3	13.1	92.3	13.1	11	2.8	2.0	5.0	3.6	.4	.7
96	12	9	8.9	.1	0.0	99.1	3.1	99.1	3.1	11	1.1	.4	9.2	3.5	.1	.4
97	13	9	8.7	.3	0.0	96.6	8.0	96.6	8.0	12	1.6	.8	7.1	3.5	.2	.6
98	13	9	8.3	.5	.2	94.0	8.3	92.3	9.1	10	1.2	.4	8.1	3.6	.5	.7
99	13	9	8.8	.2	0.0	97.4	6.4	97.4	6.4	10	1.6	.7	7.0	4.2	.1	.2
100	13	9	8.8	.2	0.0	98.3	4.0	98.3	4.0	11	1.8	1.6	10.0	9.3	.0	.1
101	13	9	8.7	.3	0.0	96.6	6.7	96.6	6.7	10	1.9	1.1	8.5	9.6	.2	.4
102	13	9	8.5	.5	0.0	94.9	7.0	94.9	7.0	9	1.7	.6	5.8	2.3	.2	.3

REPORT FORMAT 1**** BOOK 13 CLASS 2 06/04/72

		AVERAGES			QUALITY		EFFICIENCY			ELAPSED TIME		C-RATE		E-RATE	
	TOTAL	RIGHT	WRONG	OMIT	AVE	SE	AVE	SE	N	AVE	SE	AVE	SE	AVE	SE
13	9	9.0	0.0	0.0	100.0	0.0	100.0	0.0	12	1.4	.4	6.9	1.9	0.0	0.0
13	9	9.0	0.0	0.0	100.0	0.0	100.0	0.0	12	1.3	.6	9.2	5.7	0.0	0.0
13	10	9.5	.3	.2	96.8	4.8	95.4	6.3	11	1.6	.7	7.0	3.1	.2	.3
13	7	6.9	.1	0.0	98.9	3.8	98.9	3.8	10	.9	.5	10.0	4.2	.1	.3
13	9	8.7	.3	0.0	96.6	6.7	96.6	6.7	12	1.7	1.1	9.0	10.3	1.1	3.3
13	7	6.9	.1	0.0	98.9	3.8	98.9	3.8	12	1.0	.5	9.0	4.2	.1	.3
12	9	8.4	.6	0.0	93.5	9.6	93.5	9.6	12	1.6	.6	6.7	4.1	.4	.6
13	9	8.7	.3	0.0	96.6	9.1	96.6	9.1	10	1.6	.5	6.0	1.7	.1	.3
13	10	9.1	.8	.2	92.3	18.5	90.8	18.6	12	1.7	.8	7.5	5.5	.3	.6
13	10	9.4	.	.1	94.6	10.8	93.8	10.8	12	1.6	.7	7.1	3.0	.4	.6
13	9	8.5	.5	0.0	94.9	9.4	94.9	9.4	13	1.6	.8	9.2	11.5	.7	1.6
13	10	8.8	1.2	0.0	87.7	20.1	87.7	20.1	13	2.3	1.2	5.3	3.5	.5	.8
13	9	8.7	.3	0.0	96.6	6.7	96.6	6.7	12	1.8	1.2	7.6	4.9	.3	.6
13	10	9.4	.6	0.0	93.8	10.8	93.8	10.8	11	1.6	.7	7.0	2.9	.7	1.1
13	9	8.5	.5	0.0	94.9	9.4	94.9	9.4	11	1.9	.9	5.7	2.9	.3	.6
13	10	8.2	1.8	0.0	82.3	26.6	82.3	26.6	12	2.1	.9	5.7	4.1	.7	1.2
13	10	9.2	.8	0.0	91.5	15.1	91.5	15.1	12	2.1	.9	5.5	2.6	.3	.5
13	9	8.6	.3	.1	96.6	5.1	95.7	5.4	13	1.9	1.5	6.8	3.7	.3	.5
13	10	9.1	.9	0.0	90.8	12.1	90.8	12.1	12	1.7	.8	6.9	3.6	.4	.6
13	9	8.5	.5	0.0	94.0	12.8	94.0	12.8	12	1.5	.6	7.6	3.9	.2	.5
13	10	8.2	1.8	0.0	81.5	27.1	81.5	27.1	13	2.2	1.3	6.0	5.0	1.2	2.2
13	10	9.6	.4	0.0	96.2	6.2	96.2	6.2	12	1.7	.7	6.7	3.0	.2	.3
12	10	9.3	.3	0.0	97.5	4.3	97.5	4.3	12	1.9	.9	6.5	3.3	.2	.5
13	9	7.2	1.8	0.0	80.3	25.2	80.3	26.2	11	2.3	1.1	4.4	3.7	.3	1.0
13	10	9.5	.5	0.0	95.4	8.4	95.4	8.4	11	1.3	.5	8.3	2.9	.4	.9
13	-20	17.2	2.6	.1	86.1	14.2	85.8	14.3	6	3.5	1.8	6.4	2.8	.5	.9

APPENDIX E

*****REPORT FORMAT 2***** BOOK 13 CLASS 2 06/04/72

PAGE	NUMBER STUDENTS	ELAPSED TIME (SECONDS) MIN	1Q	MEDIAN	3Q	MAX	C-RATE (MINUTES) MIN	1Q	MEDIAN	3Q	MAX
1	14	15.0	42.5	92.5	155.0	180.0	1.67	1.94	3.30	6.17	20.00
2	12	25.0	47.5	72.5	122.5	190.0	2.53	3.92	6.20	10.00	16.80
3	11	20.0	40.0	75.0	85.0	475.0	1.01	5.65	6.40	12.00	21.00
4	10	20.0	31.5	65.0	142.5	210.0	2.86	4.21	9.45	17.66	30.00
5	14	5.0	30.0	55.0	66.3	95.0	3.16	4.33	5.45	10.00	60.00
6	12	25.0	37.5	60.0	85.0	220.0	2.18	5.73	8.00	12.86	19.20
7	13	25.0	75.0	90.0	145.0	270.0	1.78	3.52	5.33	6.43	19.20
8	12	30.0	45.0	65.0	131.3	195.0	3.08	4.58	9.23	13.33	20.00
9	11	15.0	25.0	45.0	85.0	135.0	3.56	5.65	10.67	14.20	32.00
10	12	20.0	47.5	57.5	91.3	180.0	3.33	6.81	10.45	12.73	31.00
11	13	20.0	37.5	55.0	95.0	130.0	4.62	6.33	10.91	16.07	30.00
12	13	10.0	45.0	75.0	95.0	140.0	3.16	4.81	6.40	10.00	48.00
13	12	10.0	41.3	55.0	80.0	245.0	1.71	6.08	8.20	11.07	48.00
14	12	20.0	47.5	60.0	107.5	130.0	4.62	5.58	9.00	12.67	30.00
15	11	20.0	35.0	50.0	110.0	190.0	2.21	3.82	8.40	12.00	21.00
16	14	20.0	37.5	45.0	70.0	75.0	8.00	8.57	13.33	16.25	30.00
17	12	30.0	50.0	67.5	117.5	210.0	2.86	5.34	8.90	12.00	20.00
18	12	30.0	36.3	55.0	73.8	135.0	2.22	3.72	4.88	7.29	10.00
19	11	40.0	45.0	60.0	90.0	225.0	2.00	5.33	7.00	10.67	12.00
20	13	25.0	42.5	55.0	125.0	215.0	2.79	4.83	10.00	14.17	24.00
21	13	20.0	35.0	60.0	85.0	245.0	2.45	7.06	10.00	16.75	30.00
22	13	20.0	45.0	60.0	122.5	285.0	2.11	4.79	9.23	13.00	27.00
23	12	25.0	48.8	75.0	106.3	270.0	2.22	5.81	8.04	12.33	24.00
24	12	45.0	55.0	82.5	118.8	155.0	3.87	4.68	7.33	10.91	13.33
25	13	20.0	50.0	60.0	85.0	120.0	5.00	7.08	10.60	12.12	30.00
26	13	50.0	62.5	95.0	115.0	145.0	4.14	5.10	6.32	9.52	12.00
27	14	15.0	52.5	80.0	116.2	145.0	4.14	5.11	7.66	11.52	36.00
28	13	35.0	55.0	65.0	110.0	175.0	3.43	5.54	9.23	10.91	15.00
29	11	15.0	35.0	45.0	95.0	165.0	1.45	2.53	6.00	8.57	20.00
30	13	20.0	30.0	45.0	100.0	135.0	2.22	3.07	5.33	10.29	15.00
31	12	20.0	46.3	62.5	98.8	130.0	2.31	2.89	4.18	6.50	15.00
32	13	30.0	75.0	100.0	187.5	215.0	2.21	2.75	4.50	7.20	14.00
33	13	45.0	57.5	90.0	127.5	405.0	1.33	3.81	4.70	9.41	12.00
34	11	15.0	90.0	100.0	120.0	220.0	2.18	4.00	4.57	5.33	24.00
35	13	40.0	82.5	115.0	177.5	230.0	2.05	3.03	4.70	6.26	13.33
36	12	50.0	66.3	100.0	122.5	165.0	2.80	3.78	5.05	8.03	10.00
37	12	50.0	81.3	117.5	157.5	240.0	2.00	3.05	4.09	5.91	8.00
38	13	10.0	65.0	75.0	120.0	410.0	1.32	4.25	7.20	8.36	48.00
39	12	15.0	58.8	100.0	116.2	140.0	3.86	4.50	5.14	9.29	24.00
40	13	25.0	50.0	80.0	145.0	190.0	2.22	2.67	4.80	8.80	13.71
41	10	30.0	67.5	102.5	152.5	325.0	1.66	3.54	4.82	8.04	10.00
42	13	35.0	62.5	80.0	122.5	445.0	1.21	4.18	6.55	7.46	15.43
43	13	35.0	77.5	95.0	187.5	210.0	2.29	2.57	4.00	5.39	13.71
44	13	30.0	60.0	125.0	182.5	235.0	2.30	2.91	4.32	9.26	15.43
45	12	60.0	66.3	102.5	152.5	350.0	1.54	3.57	5.30	7.32	9.00
46	14	35.0	62.5	120.0	166.2	505.0	.95	2.78	3.54	6.96	13.71
47	12	50.0	60.0	75.0	118.8	265.0	2.04	4.55	6.87	8.23	10.00
48	13	45.0	62.5	100.0	167.5	305.0	1.77	3.20	5.33	7.53	13.33
49	13	20.0	80.0	125.0	175.0	235.0	2.00	2.38	3.84	6.22	15.00
50	14	40.0	73.8	102.5	122.5	235.0	2.30	4.41	5.27	8.21	12.00

REPORT FORMAT 2**** BOOK 13 CLASS 2 06/04/7?

NUMBER STUDENTS	ELAPSED TIME (SECONDS) MIN	1Q	MEDIAN	3Q	MAX	C-RATE (MINUTES) MIN	1Q	MEDIAN	3Q	MAX
14	20.0	60.0	90.0	120.0	165.0	3.00	4.50	5.84	8.48	21.00
12	10.0	88.8	135.0	170.0	250.0	1.92	2.81	3.50	4.91	42.00
12	10.0	70.0	92.5	148.7	235.0	2.04	3.65	5.19	7.71	42.00
14	25.0	67.5	117.5	161.2	260.0	2.08	3.35	4.16	7.39	16.80
13	35.0	57.5	105.0	165.0	420.0	1.43	3.64	5.71	9.50	17.14
13	15.0	52.5	90.0	150.0	220.0	1.91	3.20	5.33	9.03	24.00
13	5.0	60.0	95.0	165.0	355.0	1.35	2.75	5.05	8.23	48.00
14	30.0	56.3	72.5	140.0	175.0	2.74	3.43	6.63	8.67	14.00
11	30.0	65.0	105.0	155.0	390.0	.92	3.64	5.71	9.23	20.00
11	35.0	45.0	90.0	110.0	145.0	4.14	5.33	6.00	10.33	17.14
13	50.0	65.0	75.0	130.0	195.0	2.46	3.70	5.60	6.69	9.60
14	35.0	73.8	97.5	115.0	340.0	1.76	5.24	6.16	8.14	19.43
12	30.0	51.3	82.5	108.7	160.0	3.38	5.02	6.18	7.69	18.00
9	50.0	87.5	155.0	225.0	515.0	2.33	5.23	7.74	12.18	20.00
13	35.0	67.5	105.0	165.0	205.0	2.63	3.27	4.94	7.86	16.00
12	35.0	61.3	125.0	143.8	275.0	2.18	3.93	4.72	8.50	17.14
9	35.0	60.0	115.0	152.5	360.0	1.50	3.66	4.70	9.00	19.43
14	15.0	27.5	100.0	151.2	210.0	2.86	3.80	5.70	21.00	33.00
13	45.0	80.0	115.0	160.0	205.0	2.63	3.61	5.22	7.53	10.00
12	10.0	52.5	77.5	127.5	205.0	1.46	2.33	2.78	4.14	24.00
14	10.0	48.8	65.0	96.3	170.0	2.82	4.54	6.93	9.40	43.00
13	45.0	77.5	95.0	130.0	395.0	1.37	4.01	5.14	6.97	12.00
13	35.0	72.5	115.0	145.0	400.0	1.35	3.51	4.32	7.98	13.71
11	30.0	45.0	75.0	130.0	200.0	2.70	3.27	7.20	10.29	18.00
11	40.0	50.0	80.0	105.0	425.0	1.13	3.53	5.05	8.40	12.00
11	10.0	50.0	75.0	110.0	180.0	2.67	4.36	6.40	9.33	36.00
10	65.0	68.8	95.0	118.8	130.0	4.62	4.84	6.32	7.56	9.23
8	80.0	90.0	115.0	147.5	180.0	3.00	3.86	4.80	6.15	9.67
9	20.0	45.0	80.0	167.5	245.0	1.22	1.84	4.00	4.90	12.00
11	30.0	70.0	90.0	110.0	180.0	2.33	4.36	5.33	6.86	15.00
12	15.0	30.0	52.5	96.3	160.0	3.38	5.64	10.00	18.00	24.00
10	45.0	80.0	120.0	180.0	280.0	2.14	3.34	4.76	7.17	12.00
12	10.0	32.5	65.0	91.3	165.0	1.09	2.19	3.23	8.00	12.00
10	30.0	40.0	60.0	93.8	155.0	3.10	5.15	7.36	10.54	16.00
12	15.0	66.3	92.5	157.5	275.0	1.96	3.43	5.88	8.16	32.00
11	15.0	20.0	60.0	100.0	215.0	.84	2.00	4.00	9.00	12.00
12	20.0	56.3	102.5	148.7	370.0	1.62	4.00	5.77	10.68	30.00
11	5.0	35.0	55.0	75.0	190.0	.95	2.67	3.69	5.33	43.60
12	50.0	81.3	95.0	158.7	235.0	2.55	3.63	5.82	6.96	8.73
13	25.0	37.5	50.0	75.0	235.0	1.02	2.79	4.80	8.43	9.60
12	40.0	56.3	97.5	155.0	240.0	2.50	3.81	6.26	10.60	13.50
9	10.0	32.5	40.0	107.5	160.0	1.13	1.98	3.00	5.57	13.00
13	55.0	62.5	85.0	150.0	390.0	1.38	3.80	6.55	7.82	10.91
12	15.0	45.3	57.5	77.5	165.0	1.82	2.85	4.68	6.50	20.00
11	40.0	90.0	125.0	200.0	495.0	1.09	3.00	4.67	5.45	15.00
11	35.0	45.0	55.0	90.0	120.0	4.50	6.00	9.82	10.67	15.43
12	40.0	51.3	90.0	131.3	195.0	2.77	4.18	6.02	10.01	13.50
10	30.0	53.8	65.0	95.0	110.0	4.91	5.68	7.25	9.15	15.00
10	30.0	70.0	82.5	125.0	190.0	2.21	4.09	6.55	7.85	18.00
11	15.0	40.0	95.0	120.0	390.0	1.38	4.50	5.68	13.50	30.00

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*****PHP REPORT FORMAT 2***** BOOK 13 CLASS 2 05/04/72

PAGE	NUMBER STUDENTS	ELAPSED TIME (SECONDS) MIN	10	MEDIAN	30	MAX	C-RATE (MINUTES) MIN	10	MEDIAN	30	MAX
101	10	15.0	56.3	107.5	160.0	235.0	2.30	2.83	5.03	9.30	35.00
102	9	50.0	77.5	100.0	122.5	170.0	2.82	4.40	5.14	7.00	10.00
103	12	50.0	62.5	77.5	98.8	125.0	4.32	5.47	6.97	9.69	10.00
104	12	25.0	38.8	85.0	113.7	140.0	3.86	4.75	6.38	14.27	21.00
105	11	50.0	60.0	90.0	140.0	165.0	3.64	4.00	6.00	10.00	12.00
106	10	25.0	30.0	47.5	60.0	135.0	3.11	6.75	8.57	14.00	16.00
107	12	10.0	55.0	90.0	123.7	255.0	2.12	4.21	6.02	9.59	42.00
108	12	25.0	40.0	55.0	65.0	150.0	2.80	5.77	7.64	10.50	15.00
109	13	30.0	70.0	90.0	108.7	180.0	3.00	4.09	5.37	7.04	13.00
110	10	55.0	75.0	90.0	117.5	160.0	3.38	4.65	6.00	7.24	9.00
111	12	25.0	68.8	92.5	148.7	185.0	2.77	3.78	6.00	6.80	24.00
112	12	50.0	56.3	95.0	120.0	210.0	2.86	5.00	6.03	10.60	12.00
113	13	10.0	52.5	90.0	135.0	175.0	3.09	3.58	6.00	9.71	48.00
114	13	50.0	70.0	110.0	210.0	240.0	1.26	2.50	3.75	8.00	12.00
115	12	30.0	42.5	102.5	150.0	295.0	1.83	3.38	5.30	12.82	10.00
116	11	45.0	55.0	85.0	150.0	155.0	3.37	4.00	7.00	8.40	13.33
117	11	45.0	60.0	100.0	135.0	220.0	2.45	3.09	4.15	8.00	12.00
118	12	40.0	67.5	125.0	171.2	235.0	1.00	2.18	4.24	8.72	15.00
119	12	60.0	81.3	102.5	168.8	220.0	1.36	3.25	5.44	6.98	10.00
120	13	40.0	47.5	85.0	137.5	390.0	1.38	3.71	6.35	10.73	15.00
121	12	40.0	62.5	87.5	142.5	190.0	2.53	3.05	6.91	9.64	15.00
122	12	35.0	46.3	100.0	118.8	150.0	3.50	4.50	5.15	11.70	15.43
123	13	30.0	55.0	120.0	170.0	260.0	.64	2.73	3.75	6.00	10.00
124	12	45.0	67.5	95.0	141.2	190.0	2.53	4.30	6.03	8.72	15.33
125	12	35.0	78.7	95.0	140.0	260.0	2.31	3.96	6.33	7.67	15.43
126	11	40.0	70.0	145.0	180.0	280.0	.41	1.67	3.09	7.71	15.00
127	11	40.0	60.0	70.0	100.0	155.0	3.87	6.00	7.50	9.23	15.00
128 TEST	5	125.0	128.7	167.5	285.0	435.0	2.48	3.39	6.84	9.32	9.56
(125 PAGES)	12.0	29.9	56.1	85.2	127.8	227.7	2.44	4.07	6.09	9.38	20.25